

*Ra Tonya Derrick*

THE STATE OF SOUTH CAROLINA  
BEFORE THE DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

IN RE: CITY OF SPARTANBURG  
ARKWRIGHT DUMP SITE  
SPARTANBURG COUNTY

CONSENT AGREEMENT

07 - 04 - HW

This Consent Agreement is entered into between the South Carolina Department of Health and Environmental Control (hereinafter "Department"), and the City of Spartanburg with respect to remediation of the Arkwright Dump Site. The Arkwright Dump is located at the north end of Hilltop Lane in the Arkwright community, immediately south of the City of Spartanburg. The Arkwright Dump Site (hereinafter "the Site") shall include the property on which the Arkwright Dump is located and all areas where contamination has migrated from the property.

**FINDINGS OF FACT**

Based on information known by the Department, the following findings of fact are asserted for purposes of this Consent Agreement:

1. The Arkwright Dump Site is a 30-acre abandoned, unpermitted landfill operated in the 1950s and 1960s by the City of Spartanburg. The landfill is believed to have accepted primarily municipal wastes; however, available information indicates that medical, automotive, and other wastes were also disposed in the landfill.
2. In 1972, the Arkwright Dump was closed and a soil cover was placed over the buried wastes.

3. The Site was initially identified to the United States Environmental Protection Agency (EPA) by the leader of a local community group, Re-Genesis, Inc., in 1998. A Preliminary Assessment by EPA was completed in 1998, recommending additional sampling. A Site Inspection, completed in 1999, identified the presence of a number of hazardous substances including inorganic compounds (heavy metals), pesticides, and organic chemicals. These substances were present in site soils, groundwater, surface water, and sediment.
4. On November 30, 1999, EPA and the City of Spartanburg entered into an Administrative Order on Consent under which the City of Spartanburg would perform a phased study of environmental contamination at the Site. Specifically, the City of Spartanburg agreed to conduct a Remedial Investigation (RI), Baseline Risk Assessment, and Feasibility Study (FS).
5. Based on the results of the RI/FS and Baseline Risk Assessment, on September 30, 2002, USEPA issued a Record of Decision (ROD) for the Site, which includes installation of an engineered cap for wastes and contaminated soils, in-situ groundwater treatment for contaminated groundwater, institutional controls, and groundwater monitoring. The ROD is incorporated herein (see Appendix A) as an enforceable part of this Agreement.
6. The Department and the City of Spartanburg agree that the City of Spartanburg will conduct the work described in the ROD without further litigation and without the admission or adjudication of any issue of fact or law.
7. The City of Spartanburg is entering into the Consent Agreement out of concern for human health and the environment and will take all necessary steps in compliance with all environmental laws to prevent future releases from the Site.

## CONCLUSIONS OF LAW

A "release" or "threat of release" of "hazardous substances" into the "environment" has occurred at the Site within the meaning of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, P.L. 96-510, as amended (CERCLA).

The Department has the authority to implement and enforce CERCLA and related regulations pursuant to the South Carolina Hazardous Waste Management Act, S.C. Code Ann. §44-56-200 (2002 and Supp. 2005), the Pollution Control Act, S.C. Code Ann. §48-1-10 et seq. (Supp. 2002), and the South Carolina Hazardous Waste Management Act, S.C. Code Ann. §44-56-10 et seq. (2002 and Supp. 2005). These Acts give the Department the authority to hold hearings; to issue orders; to assess civil penalties and conduct studies, investigations, and research; to abate, control and prevent pollution; and to protect the health of persons or the environment.

**NOW, THEREFORE IT IS AGREED** with the consent of the City of Spartanburg (hereinafter "the City") and the Department and pursuant to §§44-56-40 and 44-56-200 of the South Carolina Hazardous Waste Management Act and §48-1-50 of the Pollution Control Act that the City shall:

1. Perform the following four (4) major components of the Presumptive Remedy for CERCLA municipal landfills identified in the ROD and any amendments thereto:

- a. Construction/Installation of a Flexible Membrane Liner (FML) Cap:

The landfill area will be capped in accordance with the Federal and State Applicable or Relevant and Appropriate Requirements for solid waste landfills, with long-term Operation and Maintenance of the cap. Waste will be moved and consolidated as necessary to bring the contents to within the boundaries shown in

the Feasibility Study (Attachment – ROD Figure I-2). The cap will consist of native soils compacted to the required permeability ( $1 \times 10^{-5}$  cm/sec), with a liner (FML) installed over the compacted soil. The liner will then be covered with soil and a vegetative cover (root zone) will be constructed on the exterior. The cap will include passive gas venting and appropriate surface-water runoff controls.

b. Implementation of Enhanced Biodegradation treatment for groundwater contamination:

Enhanced Biodegradation treatments will be performed on groundwater to enhance or accelerate microbial degradation/destruction of Site chemicals or constituents of concern (COCs). A Treatability Study will be conducted to determine the most effective delivery strategies and gather necessary design information. One or more similar process options, such as injection of hydrogen release compound, molasses, vegetable oil, or others, may be used. Unless determined otherwise in the Treatability Study, the treatment will be targeted on those areas around the edge of the landfill that were found in the RI to be significant sources of contaminants leaching to groundwater.

c. Implementation of Institutional Controls:

Institutional Controls will be necessary during soil movement and cap placement to prevent exposure to Site soils, since physical access to the Site is unrestricted and the cap may require 12-15 months or more to install. Additionally, in that hazardous substances in excess of residential standards will exist at the Site after the City has completed the actions required under this Agreement, the City shall ensure that the Site owner enters into and files a restrictive covenant. Upon the

Department's approval of the items outlined therein, the restrictive covenant shall be signed by the Department and the Site owner and witnessed, signed, and sealed by a notary public. The Site owner or the City shall file this restrictive covenant with the Register of Mesne Conveyance or Deeds in Spartanburg County. The signed covenant shall be incorporated into this consent agreement as an Appendix. With the approval of the Department, the restrictive covenant may be modified in the future if additional remedial activities are carried out which meet appropriate clean up standards at that time or circumstances change such that the restrictive covenant would no longer be applicable. The Department may require the Site owner, the City, or subsequent owners of the Site to modify the restrictive covenant if a significant change in law or circumstances requiring remediation occurs. The City, Site owner, or subsequent owners of the Site shall file an annual report with the Department by May 31st of each year detailing the current land uses and compliance with the restrictive covenants for as long as the restrictive covenant remains in effect on the Site. The report may be submitted in a manner prescribed by the Department.

d. Groundwater Monitoring:

Groundwater monitoring for Site COCs will be performed during the Remedial Design and Remedial Action phases, to monitor groundwater conditions before and after cap installation, and monitor the progress of treatment.

2. On or before November 1, 2007, notify the Department in writing of the name, title, and contact information of the environmental consultant that the City selects to direct and supervise all aspects of the work to be performed by the City pursuant to this Agreement.

The Department will approve or disapprove of the selected consultant in writing and will provide further information to assist in consultant selection if the initial proposal is rejected.

3. Within sixty (60) days of written approval of an environmental consultant, submit to the Department, for approval, a Remedial Design/Remedial Action (hereinafter "RD/RA") Work Plan, including a schedule of implementation of the Remedial Action and a schedule of long-term monitoring of groundwater. Any comments generated through the Department's review of the RD/RA Work Plan must be addressed in writing by the City within thirty (30) days of receipt of said comments by the City. Upon Department approval of the RD/RA Work Plan and the time schedule for implementation thereof, the RD/RA Work Plan and schedule shall be incorporated herein and become an enforceable part of this Consent Agreement.
4. Further, upon approval of the RD/RA Work Plan, the City shall submit a Remedial Design to the Department in accordance with the schedule established in the approved RD/RA Work Plan. Any comments generated through the Department's review of the Remedial Design must be addressed in writing by the City within thirty (30) days of receipt of said comments by the City. Upon Department approval of the Remedial Design and the time schedule for implementation thereof, the Remedial Design and schedule shall be incorporated herein and become an enforceable part of this Consent Agreement. The City shall begin to implement the approved Remedial Design and schedule within thirty (30) days of the Department's approval of the Remedial Design and thereafter take all necessary and reasonable steps to ensure timely completion of the remedy.

5. Submit to the Department a written monthly progress report within thirty (30) days of initiation of the RD/RA Work Plan and once every month thereafter until completion of the work required under this Consent Agreement. The monthly progress report shall include the following: (a) a description of the actions which the City has taken toward achieving compliance with this Consent Agreement during the previous month; (b) results of sampling and tests, in summary format received by the City during the reporting period; (c) description of all actions which are scheduled for the next month to achieve compliance with this Consent Agreement, and other information relating to the progress of the work as deemed necessary or requested by the Department; and (d) information regarding the percentage of work completed, any delays, encountered or anticipated, that may affect the future schedule for implementation of the Work Plan, and a description of efforts made to mitigate delays or avoid anticipated delays.
6. Prepare all plans and perform all activities under this Consent Agreement in accordance with the technical intent of the National Contingency Plan and applicable EPA guidance. Three (3) copies of each document prepared under this Consent Agreement shall be submitted to the Department's project manager:

Reginald Robinson, Project Manager – Arkwright Dump Site  
Division of Site Assessment & Remediation  
Bureau of Land & Waste Management  
South Carolina Department of Health and Environmental Control  
2600 Bull Street  
Columbia, South Carolina 29201

7. Notify the Department in writing at least five (5) days before the scheduled date if any event occurs which causes or may cause a delay in meeting any of the above-scheduled dates for completion of any specified activity pursuant to this Consent Agreement. The

City shall describe in detail the anticipated length of the delay, the precise cause or causes of delay, if ascertainable, the measures taken or to be taken to prevent or minimize the delay, and the timetable by which the City proposes that those measures will be implemented. The Department shall provide written notice to the City as soon as practicable that a specific extension of time has been granted or that no extension has been granted. An extension shall be granted for any scheduled activity delayed by an event of force majeure which shall mean any event arising from causes beyond the control of the City that causes a delay in or prevents the performance of any of the conditions under this Consent Agreement including, but not limited to: a) acts of God, fire, war, insurrection, civil disturbance, explosion; b) adverse weather conditions that could not be reasonably anticipated causing unusual delay in transportation and/or field work activities; c) restraint by court order or order of public authority; d) inability to obtain, after exercise of reasonable diligence and timely submittal of all required applications, any necessary authorizations, approvals, permits, or licenses due to action or inaction of any governmental agency or authority; and e) delays caused by compliance with applicable statutes or regulations governing contracting, procurement or acquisition procedures, despite the exercise of reasonable diligence by the City. Events which are not force majeure include by example, but are not limited to, unanticipated or increased costs of performance, changed economic circumstances, normal precipitation events, or failure by the City to exercise due diligence in obtaining governmental permits or performing any other requirement of this Consent Agreement or any procedure necessary to provide performance pursuant to the provisions of this Consent Agreement. Any extension shall be granted at the sole discretion of the Department, incorporated by

reference as an enforceable part of this Consent Agreement, and, thereafter, be referred to as an attachment to the Consent Agreement.

8. Comply with any time schedule in the approved Work Plans or any extension approved by the Department. Failure to comply with any time schedule may be considered a violation of the provisions of this Consent Agreement, and, therefore, may be deemed a violation of the South Carolina Hazardous Waste Management Act and the Pollution Control Act, as provided for in the final paragraph of this Consent Agreement.
9. Implement a community relations plan and opportunity for public comment on the work required under this Consent Agreement in accordance with the National Contingency Plan.
10. In consideration of the City's performance of all approved work under this Consent Agreement, the Department covenants not to sue or take any other civil or administrative action against the City for "Covered Matters." "Covered Matters" shall be limited to those matters specifically covered in this Consent Agreement, including but not limited to all Work Plans included herein. "Covered Matters" does not include: (a) claims based on the failure of the City to meet the requirements of this Consent Agreement; (b) any liability for any claim related to or arising out of response actions taken, selected, or ordered by the Department that are designed in whole or in part to respond to a release or threatened release of hazardous substances or pollutants or contaminants into surface water or ground water at or near the Site; (c) any claim for recovery of response costs incurred by the Department and EPA; (d) criminal actions or liabilities; (e) claims for damages to natural resources; (f) any contamination or condition not previously known nor revealed by the results of all Work Plans, but discovered by or made known to the

Department after completion of all approved Work Plans; and, (g) all other matters not specifically covered in the approved Work Plans and this Consent Agreement.

With respect to future liability for Covered Matters, this covenant not to sue shall take effect upon the Department's written certification of approval of all written report(s) required by this Consent Agreement and submitted by the City to the Department describing the results of the activities performed pursuant to all approved Work Plans, specified in this Consent Agreement.

11. Nothing in this Consent Agreement is intended to be, or shall be construed as, a release or covenant not to sue for any claim or cause of action, administrative or judicial, civil or criminal, past or future, in law or equity, which the Department may have against the City for any matters not expressly included in "Covered Matters."
12. Nothing in this Consent Agreement is intended to be, or shall be construed as, a release or covenant not to sue for any claim or cause of action, administrative or judicial, civil or criminal, past or future, in law or equity, which the Department may have against any person, firm, corporation or other entity not a signatory to this Consent Agreement.
13. In consideration for the Department's covenant not to sue, the City agrees not to assert any claims or causes of action against the Department arising out of response activities undertaken at the Site, or to seek any other costs, damages or attorney's fees from the Department arising out of response activities undertaken at the Site except for those claims or causes of action resulting from the intentional or grossly negligent acts or omissions of the Department.
14. Upon the City's fulfillment of the terms of this Consent Agreement, as approved by the Department, any liability of the City to the Department for "Covered Matters" will be

deemed resolved as between the City and the Department and that the Department shall make no claims against the City for "Covered Matters." Nothing in this Consent Agreement shall prohibit the Department from bringing or taking future response or remedial actions that may be required at the Site and from seeking any relief in law or equity from any and all responsible parties.

15. The Department and the City agree that as of the effective date of this Consent Agreement that the City is entitled to protection from contribution actions or claims as provided by CERCLA Section 113(f)(2), 42 U.S.C. §9613(f)(2) for Covered Matters.
16. Employees of the Department and the EPA and their respective consultants and contractors will not be denied access during normal business hours or at any time work under this Consent Agreement is being performed or during any environmental emergency or imminent threat situation, as determined by the Department (or as allowed by applicable law).
17. This Consent Agreement shall be binding upon and inure to the benefit of the City and its officers, directors, agents, receivers, trustees, heirs, executors, administrators, successors, and assigns and upon any successor agency of the State of South Carolina that may have responsibility for and jurisdiction over the subject matter of this Consent Agreement. The City may not assign its rights or obligations under this Consent Agreement without the prior written consent of the Department.
18. The City does not admit, accept or concede the Findings of Fact or Conclusions of Law set forth in this Consent Agreement and specifically reserves the right to contest any such Findings of Fact or Conclusions of Law in any subsequent proceeding regarding the Site. The Consent Agreement shall be admissible in any enforcement action brought by the

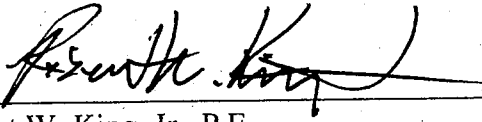
Department but may not be utilized by third parties against the City as proof of any allegations, findings or conclusions contained herein.

19. The City specifically denies any legal responsibility for response costs or damages, and does not, by signing this Consent Agreement, waive any rights which it may have to assert any claims in law or equity against any other person, company or entity not a signatory to this Consent Agreement with respect to the Site.

IT IS FURTHER ORDERED AND AGREED that this Consent Agreement governs only the City of Spartanburg's liability to the Department for civil sanctions arising from the matters set forth herein and constitutes the entire agreement between the Department and the City of Spartanburg with respect to the resolution and settlement of the matters set forth herein. The parties are not relying upon any representations, promises, understandings or agreements except as expressly set forth within this Agreement.

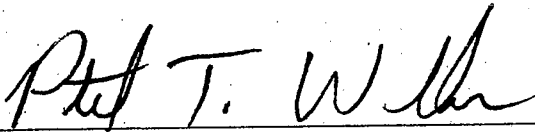
IT IS FURTHER AGREED that failure to meet the deadlines established herein or any other violation of the provisions of this Consent Agreement or applicable law may be deemed a violation of the South Carolina Hazardous Waste Management Act, the South Carolina Pollution Control Act, or both, and, therefore, may be deemed unlawful. Upon ascertaining any such violation, appropriate action may be initiated by the Department in the appropriate forum to obtain compliance with the provisions of this Consent Agreement and the aforesaid Acts.

FOR THE SOUTH CAROLINA DEPARTMENT  
OF HEALTH AND ENVIRONMENTAL CONTROL



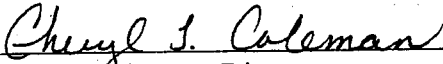
Robert W. King, Jr., P.E.  
Deputy Commissioner  
Environmental Quality Control

Date: 10/16/07



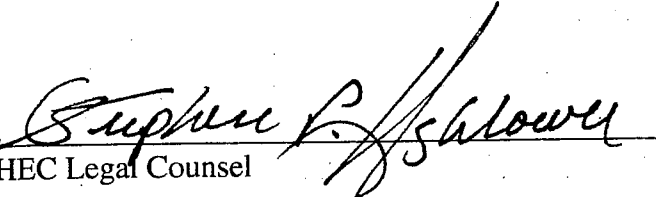
Patrick T. Walker  
Bureau Chief  
Bureau of Land and Waste Management

Date: 10/4/07



Cheryl T. Coleman, Director  
Division of Compliance and Enforcement  
Bureau of Land and Waste Management

Date: 10/3/07

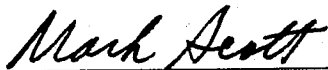


DHEC Legal Counsel

Date: 10/11/07

WE CONSENT:

CITY OF SPARTANBURG



Name:  
Title: city manager

Date: 9-19-07

Name:  
Title:

Date: \_\_\_\_\_

## **APPENDIX A**

SITE: Arkwright  
BREAK: 5.9  
OTHER: \_\_\_\_\_

Arkwright Dump Site  
Spartanburg, Spartanburg County, South Carolina

## RECORD OF DECISION



U.S. Environmental Protection Agency - Region IV  
Atlanta, Georgia  
September 2002

10050992



## **PART 1: DECLARATION**

### **A. SITE NAME AND LOCATION**

Arkwright Dump Site  
CERCLIS ID No. SC0 002 333 229  
Spartanburg, Spartanburg County, South Carolina

### **B. STATEMENT OF BASIS AND PURPOSE**

This decision document presents the Selected Remedy for the Arkwright Dump Site, a municipal landfill in Spartanburg, Spartanburg County, South Carolina, which was chosen in accordance with CERCLA, as amended by SARA, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan. This decision is based on the Administrative Record for this Site.

### **C. ASSESSMENT OF THE SITE**

The response action selected in this Record of Decision is necessary to protect the public health, welfare, or the environment from actual or threatened releases of hazardous substances into the environment from this Site.

### **D. DESCRIPTION OF THE SELECTED REMEDY**

The selected remedy employs the Presumptive Remedy for CERCLA municipal landfills (containment) as one of four (4) major components, which are briefly listed below:

- Construction / Installation of a Flexible Membrane Liner (FML) Cap:  
The landfill area will be capped in accordance with the Federal and State ARARs for solid waste landfills, with long-term O&M of the cap. Waste will be moved and consolidated as necessary to bring the contents to within the boundaries shown in the Feasibility Study (ROD Figure I-1). The cap will consist of native soils compacted to the required permeability ( $1 \times 10^{-5}$  cm/sec), with a liner (FML) installed over the compacted soil. The liner will then be covered with soil and a vegetative cover (root zone) will be constructed on the exterior. The cap includes passive gas venting and appropriate surface-water runoff controls.
- Implementation of Enhanced Biodegradation treatment for groundwater contamination:  
Enhanced Biodegradation treatments will be performed on groundwater to enhance or accelerate microbial degradation / destruction of Site COCs. A Treatability Study will be conducted to determine the most effective delivery strategies and gather necessary design information. One or more similar process

options such as injection of HRC, molasses, vegetable oil, or others may be used. Unless determined otherwise in the Treatability Study, the treatment will be targeted on those areas around the toe of the landfill that were found in the RI to be significant sources of contaminants leaching to groundwater.

- **Institutional Controls:**

Institutional controls will be necessary to prevent exposure to Site soils, since physical access to the Site is unrestricted and the cap will require 12-15 months to install. Controls may include easements, covenants, or possibly deed notices. Similarly, institutional controls to restrict the use of groundwater may be necessary on adjoining properties underlain by offsite-migrating groundwater containing Site Chemicals of Concern (COCs). Since land uses on and near the Site are undecided, an Institutional Controls Plan will be prepared during Remedial Design to ensure that Site use remains consistent with the remedy.

- **Groundwater Monitoring:**

Groundwater monitoring for Site Contaminants of Concern will be performed during the Remedial Design and Remedial Action phases, to monitor groundwater conditions before and after cap installation, and monitor the progress of treatment.

## **E. STATUTORY DETERMINATIONS**

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

Since this is a Presumptive Remedy (CERCLA landfill) site, direct treatment or removal of the source materials in the landfill is not feasible. Therefore, under the Presumptive Remedy, the preference for treatment of wastes, rather than containment, cannot reasonably be met.

This remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that would allow for unlimited use and unrestricted exposure. Use of the Site will always be restricted to the degree necessary to maintain the cap and assure its integrity. Therefore, an initial statutory Five-Year Review will be conducted five (5) years after Remedial Action construction begins, and additional reviews will be conducted every five years in accordance with the NCP.

**F. DATA CERTIFICATION CHECKLIST**

The following information is included in the Decision Summary section of this Record of Decision. Additional information can be found in the Administrative Record file for this Site.

- ☐ Chemicals of concern (COC) and their respective concentrations.
- ☐ Baseline risk represented by the COCs.
- ☐ Cleanup levels established for COCs and the basis for the levels.
- ☐ How source materials constituting principal threats are addressed.
- ☐ Current and reasonably anticipated future land use assumptions and current and future beneficial uses of groundwater considered in the baseline risk assessment and ROD.
- ☐ Potential land and groundwater use that will be available at the Site as a result of the Selected Remedy.
- ☐ Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected.
- ☐ Key factors that led to selecting the remedy.

**G. AUTHORIZING SIGNATURE**

Richard D. Green  
Director  
Waste Management Division  
Region IV  
United States Environmental Protection Agency

30 SEP 02

Date

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## PART II: DECISION SUMMARY

### A. SITE NAME, LOCATION, AND DESCRIPTION

#### A.1 Site Identification and Location

The Arkwright Dump Site has been assigned US EPA ID Number SC0 002 333 229. The Site is an abandoned landfill located just south of the city limits of Spartanburg, in Spartanburg County, South Carolina (Figure A-1). The geographical coordinates are latitude N 34 deg 55 min 04 sec, longitude W 81 deg 55 min 14.2 sec.

#### A.2 Site Type

The Site is a 30-acre abandoned landfill. It was operated in the 1950s and 1960s by the City of Spartanburg.

#### A.3 Lead and Support Agencies

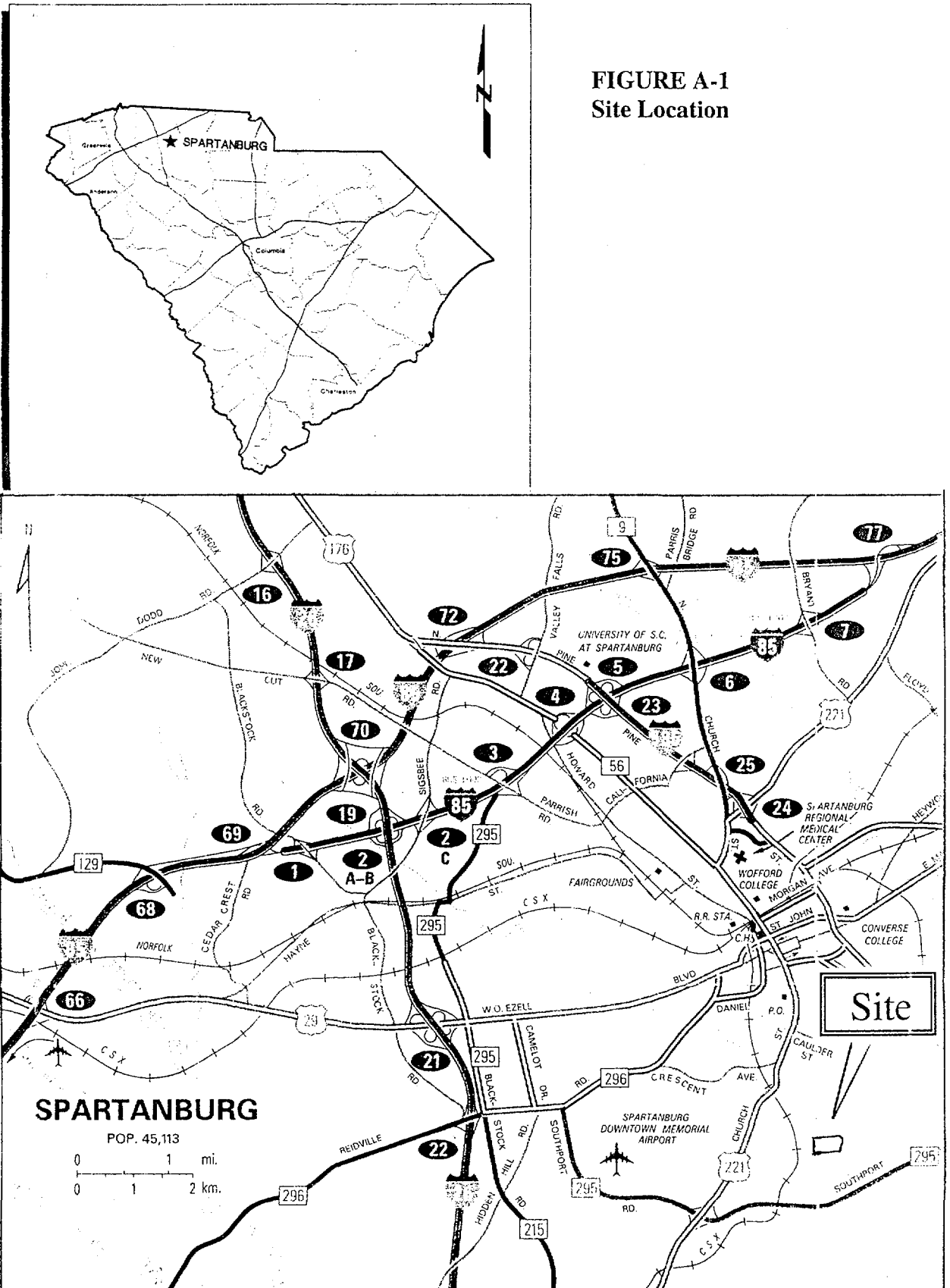
US EPA Region 4 has served in the lead agency role for all CERCLA activities to date. The South Carolina Department of Health and Environmental Control, Office of Environmental Quality Control, is the support agency.

#### A.4 Source of Cleanup Monies

Pursuant to the Administrative Order on Consent for the RI/FS, effective November 30, 1999, costs for the RI/FS and for EPA oversight have been paid by The City of Spartanburg. EPA intends to negotiate an order or consent decree with the city and other PRPs for RD/RA and for past response costs.

#### A.5 Brief Site Description

The Arkwright Dump Site is located at the north end of Hilltop Lane in the Arkwright community, immediately south of Spartanburg, South Carolina (see Figure A-2). During the 1950s and 1960s, the City of Spartanburg operated a landfill on the Site. The landfill is believed to have accepted primarily municipal wastes; however, available information indicates that medical, automotive, and other wastes were also disposed of in the landfill. In 1972, the dump was closed and a soil cover placed over the buried wastes. No development has occurred on the Site since the 1972 closure. In 1976 the City sold the property to a private citizen. To date, no operating records or permits for the landfill have been found by the city, SCDHEC, or EPA.



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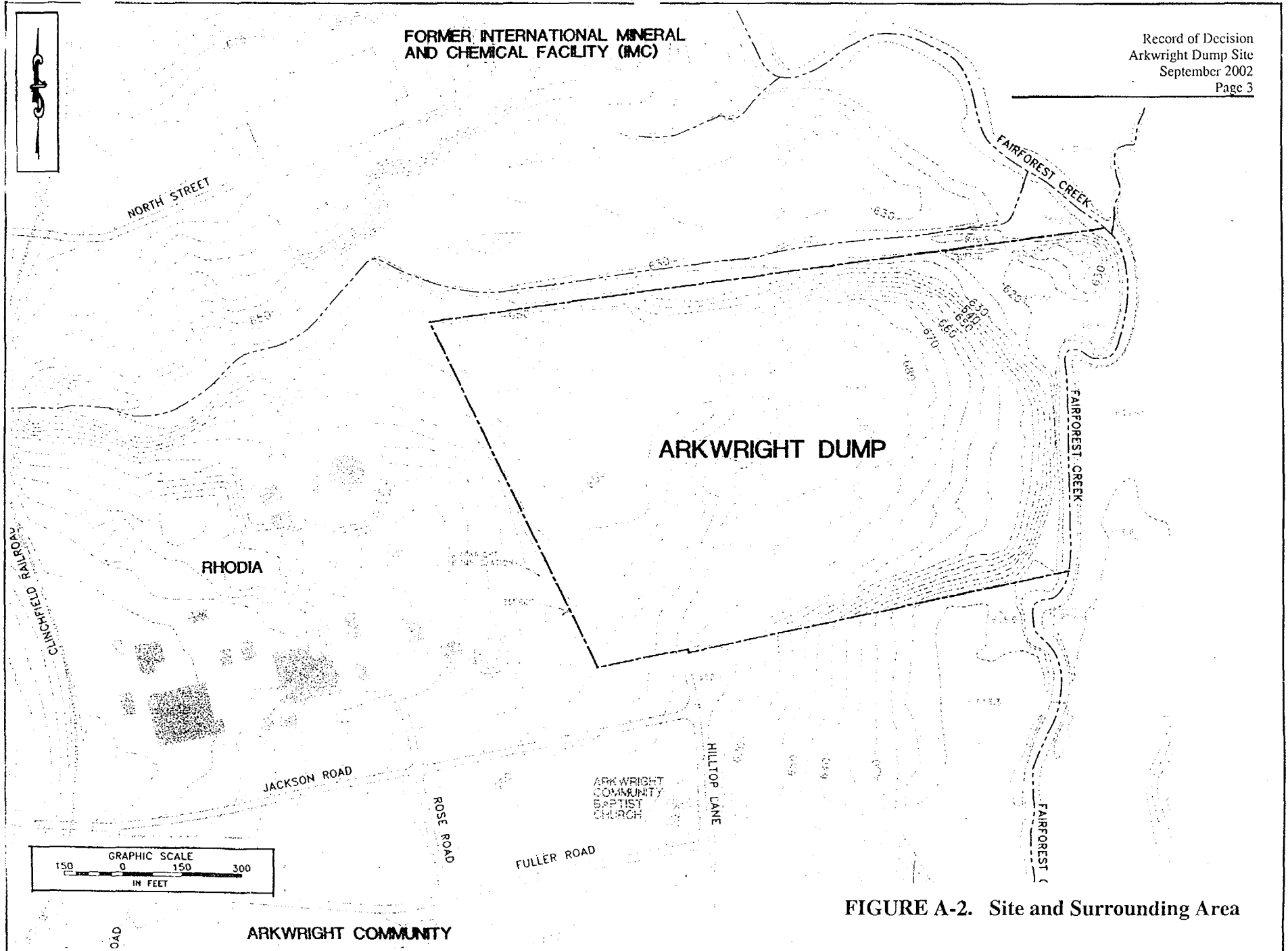


FIGURE A-2. Site and Surrounding Area

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## **B. SITE HISTORY AND ENFORCEMENT ACTIVITIES**

### **B.1 History of Site Investigations**

State environmental agency records do not indicate any previous environmental investigations at the Site. State personnel at the local Appalachia District III office (Spartanburg) were aware of the existence of the former landfill and referred to it as "the Arkwright Dump." Spartanburg County and City of Spartanburg officials indicated they were unaware of any previous environmental work.

Information from a 1999 EPA study of aerial photography, nearby residents, and City of Spartanburg personnel indicates that a dump (later a landfill) was operated at the Site by the City during the 1950s and 1960s. The landfill is believed to have accepted primarily municipal wastes; however, available information suggests that medical, automotive, and other wastes were also probably disposed of in the landfill. In 1972, the dump was closed and a soil cover placed over the buried wastes. The City of Spartanburg sold the property to a private citizen in 1976. No landfill operating records or permits have been located to date.

The Site was initially identified to EPA in February 1998 by the leader of a local community group. In early 1998, an EPA On-Scene Coordinator (OSC) of the Region 4 Emergency Response and Removals Branch conducted a site visit and walk-through and determined that no immediate, short-term threats to human health were present. Based on discussions with the nearby community and after consultation with SCDHEC representatives, EPA then elected to evaluate the Site under Superfund using Federal contract resources. A Preliminary Assessment (PA) was completed between June and September 1998, recommending that additional sampling be conducted. A Site Inspection (SI) was then conducted between October 1998 and May 1999, which identified the presence of a number of hazardous substances including inorganic compounds (heavy metals), pesticides, and organic chemicals. These substances were present in Site soils, groundwater, surface water, and sediment.

During 1998 and 1999, EPA conducted initial and confirmatory sampling events on five (5) potable water wells, representing all those known to be in use within 1/4-mile of the Site. Based on these sample results, Region 4's Emergency Response and Removals Branch connected two nearby residences having affected private water wells to the Spartanburg municipal water supply, in May 1999. Remedial Investigation findings indicate that the contamination in those wells is highly unlikely to originate from the Site.

### **B.2 CERCLA Enforcement Activities**

During June and July 1999, EPA Region 4 staff and representatives of the City of Spartanburg met and discussed the need for further investigation and eventual cleanup of the Site. These discussions culminated with the signature of an Administrative Order on Consent (AOC) for a

Remedial Investigation/Feasibility Study (RI/FS). The agreement was signed by EPA and became effective on November 30, 1999. In view of the agreement, EPA decided not to list the Site on the NPL, but rather to address the Site under an NPL-equivalent process (now known as the "Superfund Alternative Cleanup approach").

PRP search and other enforcement activities have been ongoing throughout the RI/FS. Enforcement work to date indicates other potentially responsible parties (PRPs) involved with the site. EPA intends to negotiate an order or consent decree with the city and other PRPs for RD/RA and for past response costs.

### C. HIGHLIGHTS OF COMMUNITY PARTICIPATION

In February 1998, the leader of a local community advocacy and redevelopment group identified the Arkwright Dump Site to EPA staff at an Environmental Justice conference in Atlanta. Most nearby residents belong to the community group, "Re-Genesis," which had (prior to non-profit incorporation) more than 1400 members. Earlier, in August 1997, an EPA Community Relations Coordinator was first contacted by Re-Genesis' leader regarding his concerns about the former IMC Fertilizer plant, which adjoins Arkwright Dump along the northern boundary (Figure A-2). Throughout all Superfund work since 1998, there has been strong and consistent activity and interest by Re-Genesis. The group initially formed around health concerns about a number of nearby sites and facilities. The Arkwright Dump and former IMC Fertilizer sites represent only a portion of the community's larger, area-wide concerns.

Community involvement for the RI/FS at this site cannot be separated from the context of the remarkable, larger and wide-ranging community-driven project undertaken by Re-Genesis since 1998, which is actively seeking to bring about community revitalization, redevelopment, and/or reuse of nearby properties and areas. This effort is likely to significantly change the character of the Site-surrounding area and bears on the land-use considerations in this Record of Decision.

In March 1998 EPA began preparations for conducting Preliminary Assessment/Site Inspections on both the former IMC Fertilizer and Arkwright Dump sites. EPA and SCDHEC conducted a Public Meeting, hosted by Re-Genesis, in April 1998 to present the planned Site Assessment work to the community. Although pleased with the plans for investigation of the Site and the adjoining former IMC Fertilizer plant, community members expressed frustration with what was described as many years of government inaction in responding to their health concerns about the Site and other nearby sites. They also expressed interest in a number of outreach areas such as redevelopment grants, "Brownfields" projects, Environmental Justice initiatives, and training on the Superfund process.

Before the SI began, in May 1998, EPA staff presented a briefing to Re-Genesis' Board of Directors concerning the site assessment work at both the Site and the adjoining former IMC Fertilizer site. Following up from the April public meeting, EPA then presented two sessions of

training to a total of approximately 80 local community attendees in late June 1998. Also in June 1998, EPA met with representatives of the City of Spartanburg and Spartanburg County, to explain the planned site assessment work as had been done with Re-Genesis. Ongoing dialogue continued through the summer of 1998, and included a series of community interview sessions by EPA and by its SI Contractor, which provided useful information about operations on the Site and nearby properties. Upon completion of the PA (September 1998), EPA used this information in planning the SI sampling onsite, which occurred in late October 1998.

Upon SI completion in May 1999, EPA issued a Fact Sheet concerning the Site sampling results and EPA's intention to seek further work at the Site. Discussions with City of Spartanburg representatives during the summer of 1999 led to the City's agreement to conduct an RI/FS. As part of the agreement, the City volunteered to arrange and fund (\$25,000) a Technical Advisor to work with for Re-Genesis, in order to more effectively involve group members in understanding and commenting on RI/FS documents. EPA signed the Administrative Order by Consent (AOC) for the RI/FS on November 30, 1999.

In early 2000, EPA established two local information repositories, to facilitate public review of information concerning both the Site and the former IMC Fertilizer Site. Staff at CC Woodson Recreation Center, closer to the site, agreed to maintain Site materials and make them available to the public on request. The Spartanburg Public Library main location, on Church Street in the downtown area, hosts a second set of Site materials. Administrative Record binders are available at both locations.

In planning for the RI/FS during January through June 2000, the City's RI/FS Contractor arranged for long-time residents' input and review of possible waste areas and locations, as had EPA's contractor during 1998. A fact sheet describing the planned RI activities, entitled "RI/FS Update," was issued in May 2000. Re-Genesis volunteered to distribute the fact sheets within their organization, which assisted EPA in its efforts to inform the community.

On July 24, 2000, an "RI Kickoff" meeting was held at Community Baptist Church, located just south of the Site. This meeting focused on then-upcoming fieldwork and the anticipated time periods expected for completing the RI and FS Reports, and also included a discussion of the "Presumptive Remedy" concept. EPA and Contractor staff who were preparing the Draft Community Involvement Plan attended the meeting and conducted the first of the community interviews that same week.

The planned sampling was completed in September 2000. However, the need for an additional phase of sampling (later designated "Phase II") soon became evident. Planning of this work took place in early 2001, followed by field work between April and September 2001. Work since October 2001 has focused on revising and finalizing the RI, FS, and risk documents.

Extensive informal communication with Re-Genesis continued throughout the two phases of the

RI. During this time the community pursued its area-wide redevelopment efforts. In 1999 the area was designated as a "Demonstration Project" of the Federal Environmental Justice Interagency Working Group. "The Re-Genesis Project," as it is now known, has secured other funding resources and added a number of agencies, stakeholders and other parties to the partnership. In May 2000 ReGenesis hosted an official delegation from South Africa who were interested in Re-Genesis' progress as an example of citizen-led community revitalization and improvement. In partnership with Spartanburg County, The ReGenesis Project eventually secured an EPA Redevelopment Grant (July 2000), a State Revolving-Fund Brownfield grant (2000), a Federal Brownfields grant (April 2001), a line-item Federal appropriation through the US Department of Housing and Urban Development for neighborhood redevelopment, and (to the State) a Federal DOT appropriation for \$1.2M for road design and construction (July 2002). The group has hosted four local redevelopment forums, two during 2000 and another two in 2001.

In addition to informal communications between EPA staff and Re-Genesis, EPA issued a series of "RI/FS Update Fact Sheets" to keep the community apprised of developments. "RI/FS Update Fact Sheet No. 2" was issued in March 2001, No. 3 in October 2001, and No. 4 in June 2002. Re-Genesis continued to assist Region 4 by distributing the sheets within their membership; generally, 150 or 200 copies were provided each time. EPA has also used and maintained a mailing list to provide information to all interested parties beyond the area close to the Site.

Throughout the RI/FS EPA solicited input on the anticipated land usage in the future. While planning work has not proceeded as fast as desired by Re-Genesis, sufficient general plans are in discussion that will allow EPA to account for them in this document (see Section F).

On July 23, 2002, EPA issued a Press Release through the Regional Office of Public Affairs, announcing issuance of the Proposed Plan and the planned public meeting date. Proposed Plan Fact Sheets were mailed out to Re-Genesis and to the mail list on July 19, 2002. A newspaper advertisement announcing the Proposed Plan, the Comment Period opening, and the meeting date, appeared in the Sunday edition of the Spartanburg Herald-Journal on July 21, 2002. The Proposed Plan Public Meeting was held on August 6, 2002. Community members raised a number of questions about the RI findings, the cap proposed in the remedy, health concerns, and other issues. Two sets of written comments, and one question on an EPA form provided at the meeting, were also received. EPA's responses to these questions and concerns is presented in Responsiveness Summary portion (Appendix A) of this Record of Decision.

#### **D. SCOPE AND ROLE OF THE RESPONSE ACTION**

The selected remedy described in Section L of this document is intended to be the final action for cleanup at this site. The remedy will address all risks posed by the affected media:

- Contaminated surface and subsurface soils, and
- Site groundwater and contaminated groundwater migrating offsite and entering surface water (Fairforest Creek).

Capping is EPA's Presumptive Remedy for municipal landfill sites. Therefore, capping is a component of the Site remedy. Contact with contaminated soils, and erosion of soils allowing offsite migration of the contaminants, will be addressed through the construction of a suitable engineered containment cover (cap) in accordance with the Presumptive Remedy. Onsite and offsite groundwater contamination will be addressed through insitu groundwater treatment, as described in Section L.

Completion of this remedy is expected to leave the property suitable for redevelopment, as long as property usage is consistent with the anticipated future use of the Site, which envisions one or more types of recreational use (Section F).

The EPA Region 4 Emergency Response and Removals Branch connected two nearby residences with contaminated water supply wells to the Spartanburg municipal water system in May 1999. (As noted earlier, subsequent RI work indicates the Site is highly unlikely to be the origin of contamination in those wells.) Other than CERCLA Site Assessment, the RI/FS is the only other response action to date. Future response actions as described in this Record of Decision will be implemented under CERCLA authority unless delegated to the State in accordance with applicable EPA policies.

## E. SITE CHARACTERISTICS

### E.1 Site Physical Setting

#### E.1.1 Topography and Surface Features

The Site is a rectangle-shaped 30-acre property bounded by Fairforest Creek to the east, a former fertilizer plant property (IMC) to the north, an active chemical-manufacturing facility (Rhodia) to the west, and homes to the south and southeast. As shown in Figure A-2, the Site lies on a northeast- to southwest-trending ridge, and slopes eastward toward Fairforest Creek, which forms the eastern Site boundary. Surface elevations range from 688 feet above mean sea level (MSL) at the top of the ridge to approximately 615 feet MSL along Fairforest Creek. The landfill has a soil cover of variable thickness and has a heavy growth of kudzu, trees, and natural vegetation. Only one structure probably related to the landfill remains at the Site, a small brick gate-house or office, located in the center of the Site along the old main road which was along the ridge line.

In addition to overland drainage toward Fairforest Creek, some portions of the northern half of Site drain to an unnamed tributary along the northern boundary with the IMC property, which flows east and converges with Fairforest Creek. Fairforest Creek flows to the south. The estimated annual mean flow rate for Fairforest Creek, measured approximately 1.25 miles downstream of the Site, was 37.8 cubic feet per second (cfs) for 1996 and 32.7 cfs for 1997. West of the main ridge, in the northwestern corner of the Site, standing water in a low-lying area

has been observed for short periods, which appears to be a recurring but non-permanent feature. Portions of the Site along Fairforest Creek lie within the 100-year flood plain, and flat-lying areas along the creek's banks are classified as wetlands.

Research conducted during the RI found no known areas of historical or archeological importance on or immediately near the Site.

#### E.1.2 Regional and Site-Specific Geology/Hydrogeology

The Site lies within the Inner Piedmont Belt of the Piedmont Geologic Province. The Inner Piedmont belt is one of several elongated, northeast-southwest trending geographic zones which make up the Southern Piedmont Province. Bedrock of this province is the product of regional metamorphism that formed several metamorphic rock types including biotite gneiss, biotite schists, quartzite, hornblende gneiss, and other gabbro-type rocks, of Precambrian to early Paleozoic age. Volcanic intrusions are also common throughout the Inner Piedmont Belt. In less-weathered zones within bedrock, fractures develop along bedding and cleavage planes and are capable of transmitting appreciable amounts of water.

Across the Inner Piedmont, the crystalline rocks have weathered into a soft clayey or sandy saprolite. Saprolite is produced when rock has been weathered in-situ (in place), through chemical alteration by infiltrating rainwater. Saprolite exhibits some structural and mineralogical characteristics of the underlying parent rock such as foliation, bedding and fractures. It can be present from the surface to as deep as 100 feet or more.

Competent bedrock was encountered onsite in several soil and monitoring well borings, at depths ranging from 25-30 feet to 50-55 feet below land surface (BLS). Rock core samples collected from several of the monitoring well borings were predominantly granite gneiss with biotite schist. Biotite gneiss bedrock observed onsite (Fairforest Creek) consisted of medium to coarse-grained quartz and feldspar with accessory biotite and muscovite. These rock types weather to a dark red, clay-rich saprolite. Soils in the Site area represent the Madison-Congaree-Cecil-Worsham soil series, which are deep, well drained, gently sloping soils displaying moderate infiltration, permeability, and water-capacity characteristics.

Regionally, the primary source of recharge to aquifers is surface infiltration, typically in the form of precipitation and snowmelt. Because rainfall is plentiful throughout most of the year, the water table is mainly affected by surface features, and tends to follow the elevation contours of the land surface. The mountainous and rolling terrain favors heavier groundwater recharge in low-lying regions rather than at higher elevations. Water table depth can range from a few feet below the surface in low-lying areas, to more than 100 feet at higher elevations.

Groundwater in the Piedmont Province occurs in a complex and interconnected two-part system of alluvium/saprolite, and underlying bedrock. Individual aquifers within the area are not

extensive, and most potable water is supplied by streams and lakes. Well yields vary greatly and depend upon the rock type, saprolite thickness, and whether fractures or zones of groundwater flow are intersected. Higher-yielding wells typically extend to depths of 150 to 250 feet, and intersect water-bearing fractures and faults.

RI activities included the completion of numerous borings for installing both temporary and permanent groundwater monitoring wells. The Site's hydrogeologic setting consists of a vadose (unsaturated) zone of saprolite, or in some places alluvium (streambed sediment), underlain by a water table (unconfined) aquifer. The water table is relatively shallow and appears to mimic the surface topography. Depth to the water table onsite ranges from approximately 6 to 42 feet BLS. Water in the shallow water table aquifer moves downgradient (Figure E-1), generally west to east, until it discharges into Fairforest Creek. Site groundwater appears to recharge from infiltrating rainwater on the higher elevation areas to the west. Based on a series of hydraulic conductivity tests on Site monitoring wells, and assuming an effective porosity of 0.45, the estimated horizontal groundwater flow velocity in the shallow aquifer is about 450 feet per year.

Measurements from wells in the deeper bedrock aquifer show a depth to groundwater ranging from approximately 8 to 63 feet BLS. As with the shallow aquifer, the groundwater flow direction is also generally eastward across the site, toward Fairforest Creek (Figure E-2). A slight upward vertical hydraulic gradient was recorded in monitor well clusters MW-1A/B and MW-4A/B/C/D, which are located along Fairforest Creek. The upward gradient indicates that the bedrock aquifer is draining upward into the bed of Fairforest Creek.

The aquifer system as a whole, onsite and regionally, is classified by EPA as "Class II B" and by South Carolina as "Class GB" groundwater. Both classifications indicate that groundwater from the aquifer system is a potential source of drinking water.

### E.1.3 Remedial Investigation

After a planning period, the RI/FS was conducted in two field activity phases: July through December 2000 (Phase I), and April through September 2001 (Phase II). The RI comprised a large investigation that included collection and analysis of more than 280 samples of groundwater, surface water, soil vapor, soil and sediment.

RI soil sampling was tailored to the Presumptive Remedy, to the degree possible. Extensive screening-level VOC surface/subsurface soil samples (37/27 respectively) were collected with the objective of locating any "hot spots" of organic compounds capable of affecting groundwater. Representative sample sets (6 each) of surface water and sediment were collected. Also, since there was essentially no information on-hand about the landfill contents, sixteen test pits were excavated for this purpose, as well as to characterize and document any landfill contents having enforcement significance.

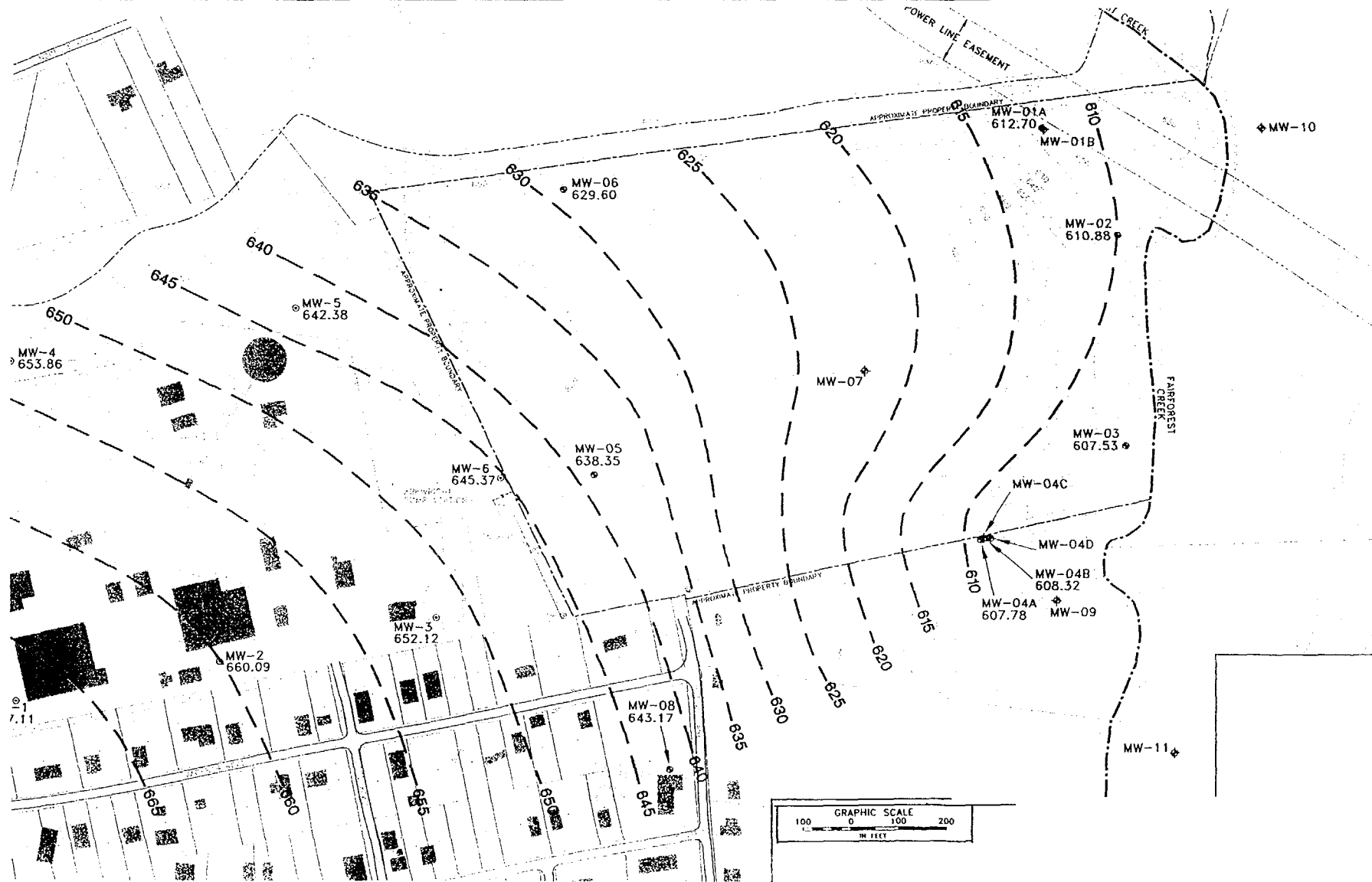


FIGURE E-1. Water Table (Shallow Aquifer) Potentiometric Surface Map

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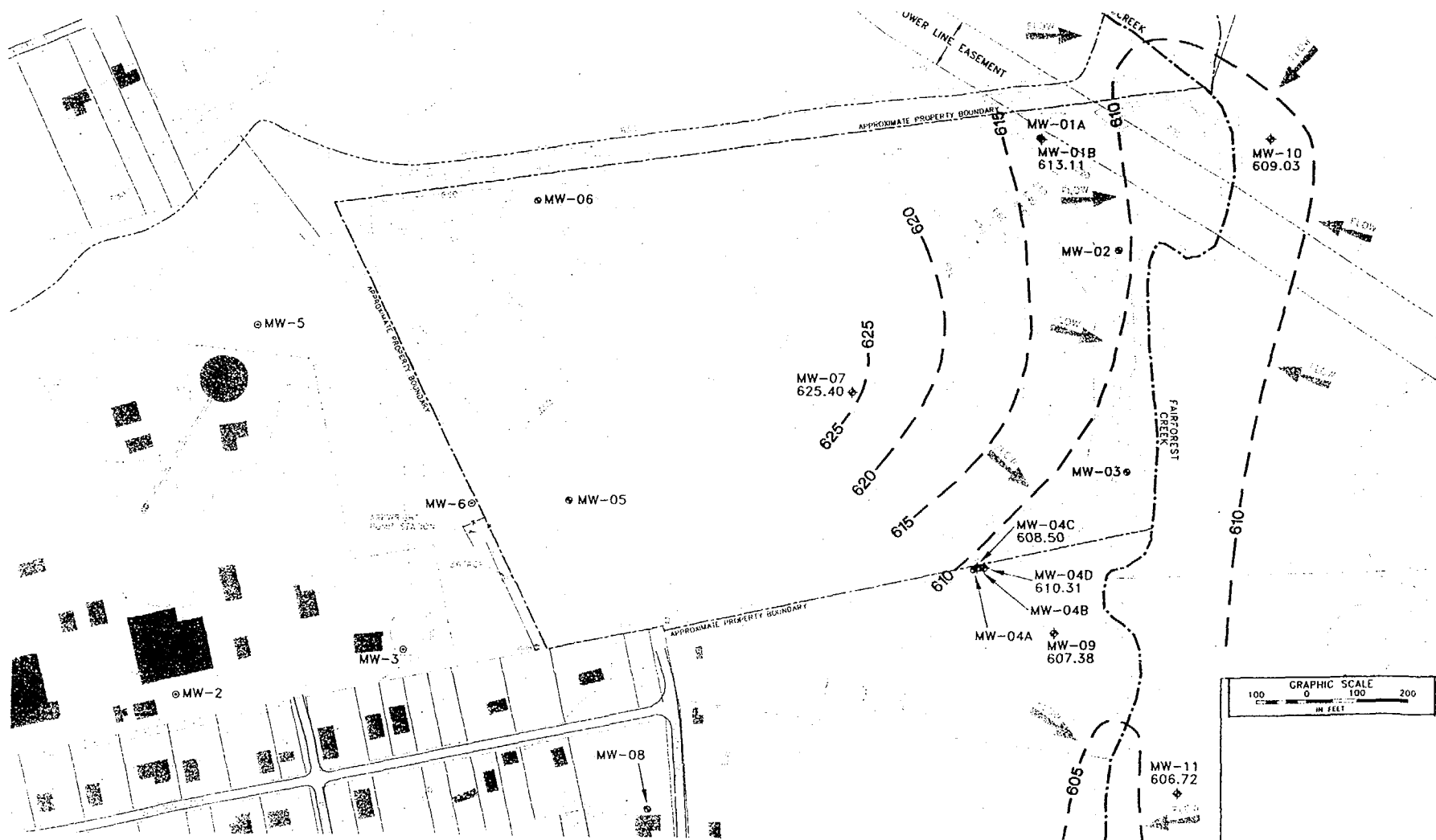


FIGURE E-2. Bedrock Aquifer Potentiometric Surface Map

Groundwater was investigated through the installation and sampling of 18 temporary monitoring wells, which then guided the placement of 15 permanent monitoring wells. Landfill gas emission was evaluated through installing and sampling 16 soil vapor wells and by conducting a soil-gas screening investigation. Figure E-3 shows the locations of all field samples collected during the RI.

Other than the landfill itself, no other potential contaminant sources of Site origin were found. Visual examination of landfill contents in test pits, considered together with the soil vapor and soil gas screening results, did not reveal any "hot spots" or areas of highly concentrated wastes. The materials seen were primarily municipal wastes (trash, plastic, glass, discarded household items, white goods), medical materials (gloves, plastic shrouds, hoods, bone fragments, syringes with needles, vials, bottles), and automotive wastes (gas tanks, wiring, miscellaneous auto parts, tires). Textile spools, bobbins and other discards were also present. An area of approximately 8-1/2 acres on the eastern toe of the landfill, an area of possible industrial wastes pointed out by residents, unfortunately proved inaccessible due to difficult field conditions which prevented safe excavation using heavy equipment.

Cross-sections of the test pits and groundwater monitoring wells indicated that the waste materials are generally above the water table depth across the landfill. According to a waste thickness map (Figure E-4) generated from Site borings, the waste pile ranges up to more than 44 feet thick. From Site boring data, the landfill waste volume is estimated to be approximately 745,000 cubic yards.

## E.2 Nature and Extent of Contamination

### E.2.1 Soil

As shown in Table E-1, eight organic and inorganic chemicals were found at levels more than two times above background or above a health screening value in surface soil, warranting consideration in the Baseline Risk Assessment (Potential Contaminants of Concern). This reflects the poor condition of the soil cover on the landfill. The most widely-detected chemical was dioxin, although levels were very low (below 1/2 microgram per kilogram ( $\mu\text{g}/\text{kg}$ ) in all cases). Sixteen chemicals were detected above background levels in subsurface soils. Burning of waste materials at the surface and below ground is reported from the past, and may be the source of dioxins in soil. Throughout this document, the term "dioxins" will refer to the entire family of related congeners of 2,3,7,8-tetrachlorodibenzo-p-dioxin, as represented in RI samples by the summary "TEQ" figure.

### E.2.2 Groundwater

Groundwater contamination (Table E-2) by volatile organic compounds (VOCs) is present, mainly in three monitor well clusters (MW-1, MW-2, MW-4) on the eastern half of the Site along

Fairforest Creek, and in an offsite well located southeast of the Site and along the creek (MW-9). The two main compounds are trichloroethylene (TCE) and tetrachloroethylene (PCE). TCE, PCE and four other VOCs exceed the Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act for aquifers which could be used as a potable water source.

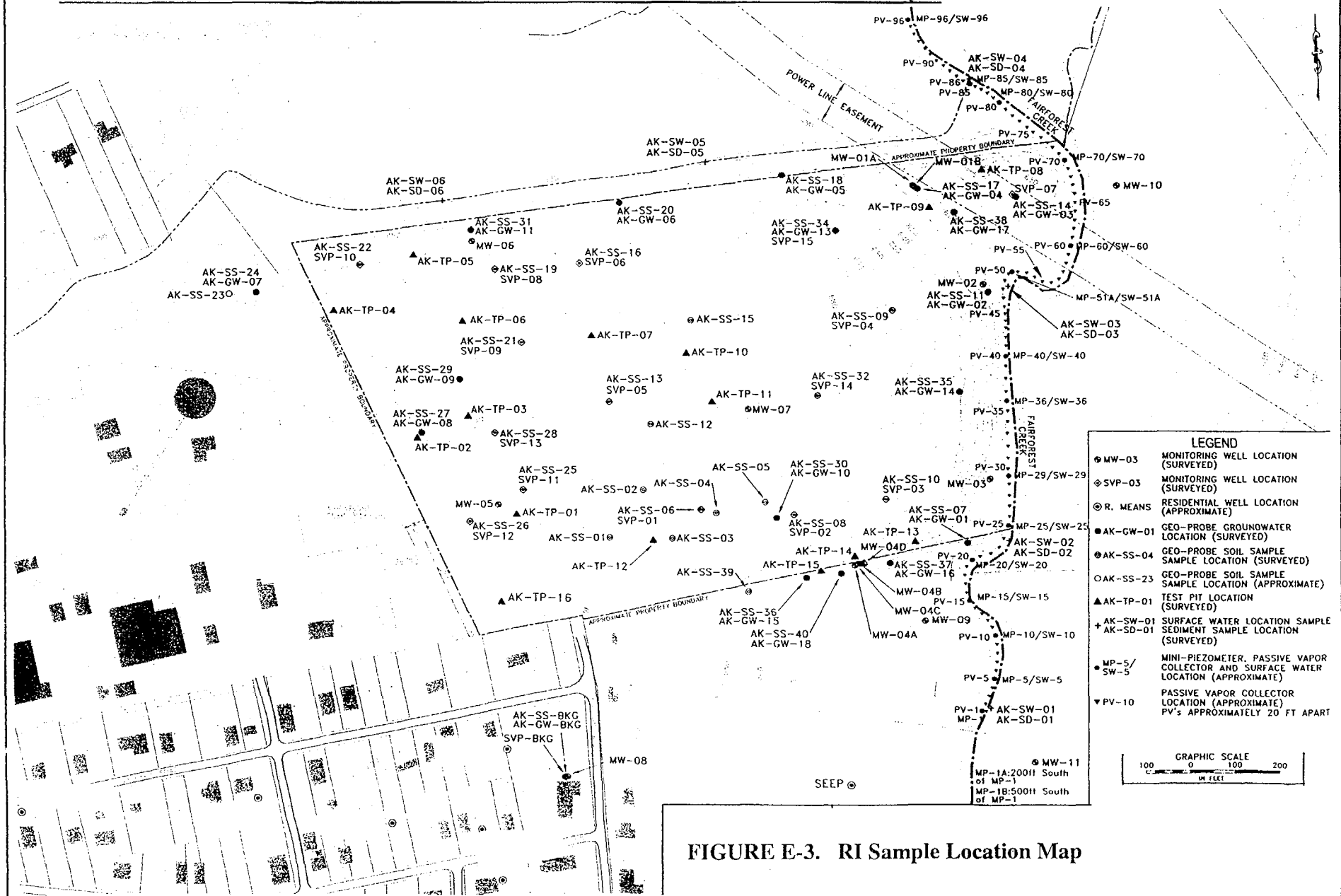
Levels of PCE ranged up to 938 micrograms per liter ( $\mu\text{g/l}$ ); TCE up to 230  $\mu\text{g/l}$ ; *cis*-1,2-dichloroethylene up to 290  $\mu\text{g/l}$ ; vinyl chloride up to 39  $\mu\text{g/l}$ ; and total VOCs up to approximately 1500  $\mu\text{g/l}$ . From the RI, 47 detected chemicals were forwarded into the Baseline Risk Assessment for consideration.

The widespread detection of *cis*- and *trans*-1,2-dichloroethene and vinyl chloride, which are microbial degradation products of tetrachloroethene, indicates that biological degradation is occurring in the aquifer.

Phase II samples of shallow groundwater entering Fairforest Creek indicate that there are two general areas where VOC-contaminated groundwater is entering at low concentrations. Individual VOC levels range from 5 to 390  $\mu\text{g/L}$  in the groundwater entering the creek. To the southeast, Site contaminants are present at MW-9 (see Figure E-3) and discharge to Fairforest Creek as far south as sample location MP-5, some 350 feet south of the property boundary. To the northeast, the VOC detections in groundwater feeding Fairforest Creek (samples MP-80 and MP-96, Figure E-3) probably also represent contaminated Site groundwater moving offsite, under the former IMC Fertilizer plant property. Location MP-96 is approximately 180 feet upstream, northwest, of the confluence of the unnamed tributary and Fairforest Creek.

These results, considered together with sample results from the Phase II deep well offsite to the southeast (MW-9); the absence of contaminants in the two Phase II deep wells on the east (offsite) side of Fairforest Creek (MW 10 and MW-11); and water table measurements from those same wells, indicate that contaminated groundwater is draining primarily to the creek and not moving offsite to the west or southwest (upgradient), where the nearest private drinking water wells are located. Although not shown in Table E-2, nine private water supply wells were sampled as a precautionary measure in the RI; two wells had lead (Pb) present above the MCL, and one well had a pesticide detection at the MCL. However, groundwater elevation measurements indicate clearly that the Site is downgradient of these wells and is not capable of impacting them. None of the wells are used for potable water supply.

In the FS, the total area underlain by groundwater contaminated above standards was estimated to be 7 acres. Considering the RI data and assuming an average affected aquifer thickness of 50 feet, with an effective porosity of 0.45, the estimated volume of contaminated groundwater is 7.2 million gallons. This estimate should be regarded as preliminary, in view of the limited number of wells (data points) defining the area.



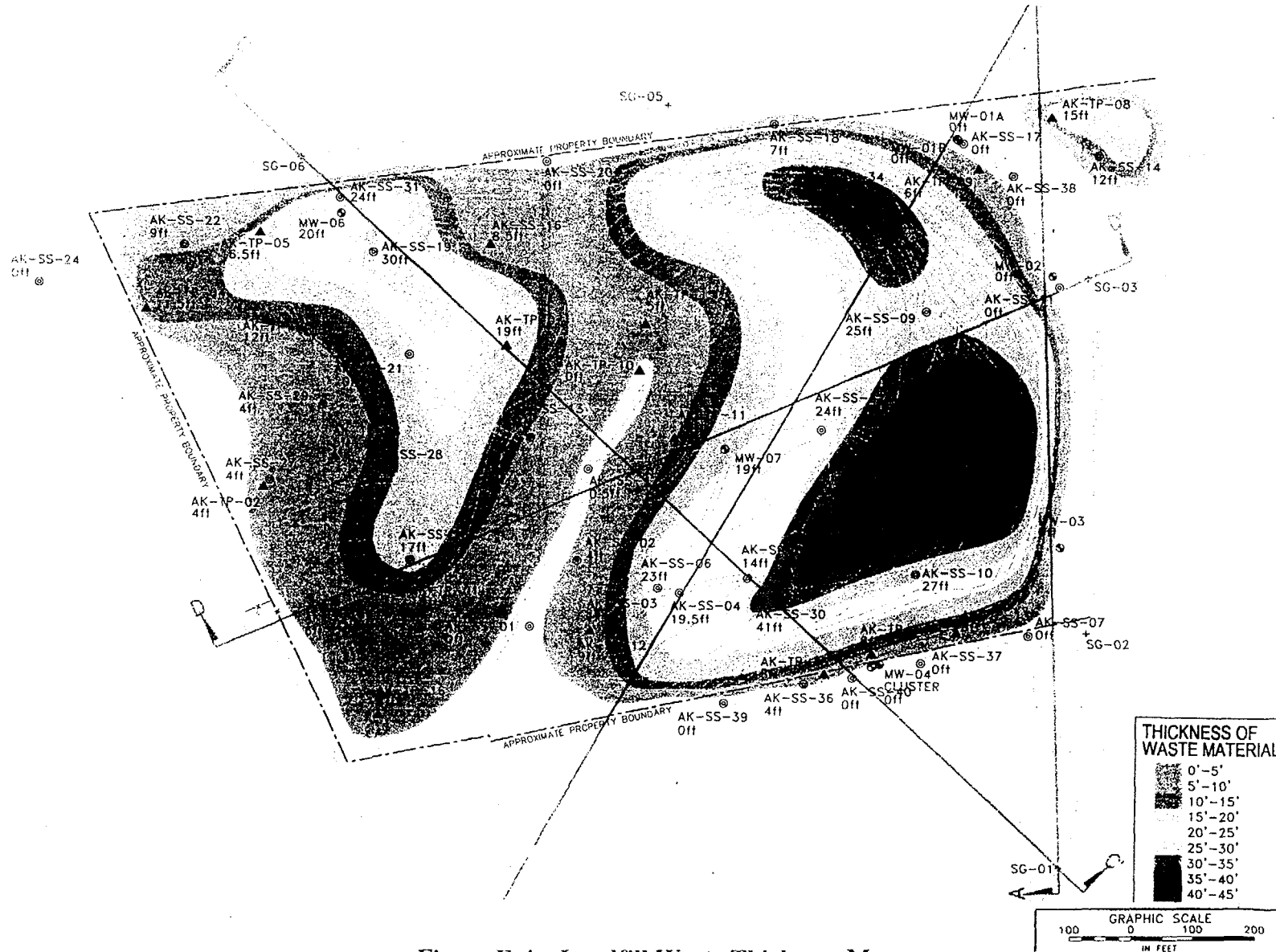


Figure E-4. Landfill Waste Thickness Map

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**TABLE E-1**  
**Surface and Subsurface Soil Sample Results**

<b>Surface Soils</b>					
<b>Chemical</b>	<b>No. Samples</b>	<b>No. Detections</b>	<b>No. above Standard</b>	<b>Maximum Detected</b>	<b>Comparison Standard Exceeded</b>
<b>Inorganics (mg/kg)</b>					
Antimony	7	3	2	11	2X Background
Arsenic	7	7	2	12	PRG-Res, PRG-Ind <sup>(1)</sup>
Copper	7	7	1	550	2X Background
Cyanide	7	1	1	5.35	2X Background
Lead	7	7	5	520	PRG - Residential <sup>(1)</sup>
Zinc	7	7	6	1200	2X Background
<b>Semivolatile Organic Compounds (µg/kg)</b>					
Benzo(a)pyrene	18	1	1	620	PRG-Res, PRG-Ind
<b>Dioxins and Furans (ng/kg)</b>					
2,3,7,8-TCDD Equivalent	18	6	5	404	PRG - Residential
<b>Subsurface Soils</b>					
<b>Chemical</b>	<b>No. Samples</b>	<b>No. Detections</b>	<b>No. above Standard</b>	<b>Maximum Detected</b>	<b>Comparison Standard Exceeded</b>
<b>Inorganics (mg/kg)</b>					
Antimony	10	2	1	8.5	2X Background
Arsenic	10	10	1	86	PRG - Res, PRG-Ind <sup>(1)</sup>
Cadmium	10	1	1	6.2	2X Background
Lead	10	10	5	1400	PRG - Res, PRG-Ind <sup>(1)</sup>
Zinc	10	10	1	2800	2X Background
<b>Semivolatile Organic Compounds (µg/kg)</b>					
Benzo(a)pyrene	10	1	1	950	PRG-Res, PRG-Ind
Benzo(a)anthracene	10	1	1	820	PRG - Residential
Benzo(b)fluoranthene	10	1	1	880	PRG - Residential
<b>Pesticides (µg/kg)</b>					
4, 4'-DDE	10	1	1	11	PRG - Residential
4, 4'-DDT	10	1	1	24	PRG-Res, PRG-Ind
<b>Dioxins and Furans (ng/kg)</b>					
2,3,7,8-TCDD Equivalent	7	7	3	413	PRG-Res, PRG-Ind

**Notes**

"2X background" indicates detections are elevated more than two times above site-specific background level.

"PRG" refers to US EPA Region 9 Preliminary Remediation Goals (Nov. 11, 2000).

"Res" = Residential use scenario PRG.

"Ind" = Industrial use scenario PRG.

(1) Detected value was also elevated >2 times background.

**TABLE E-2**  
**Groundwater Sample Results**

Chemical	No. Samples	No. Detections	No. above Standard	Maximum Detected	Comparison Standard Exceeded
<b>Inorganics (mg/kg)</b>					
Arsenic	17	1	1	0.005	PRG <sup>(1)</sup>
Manganese	17	17	8	5.3	PRG
<b>Volatile Organic Compounds (μg/kg)</b>					
Benzene	28	8	6	50	MCL (5), PRG
Chlorobenzene	28	11	1	17	PRG <sup>(2)</sup>
Chloroform	28	1	1	1.8	PRG
<i>m</i> -Dichlorobenzene	28	1	1	8	PRG
<i>p</i> -Dichlorobenzene	28	2	2	9	PRG
1,1-Dichloroethene	28	4	4	7.3	MCL (7), PRG <sup>(3)</sup>
<i>cis</i> -1,2-Dichloroethene	28	17	7	290	MCL (70), PRG <sup>(4)</sup>
<i>trans</i> -1,2-Dichloroethene	28	8	1	27	PRG <sup>(3)</sup>
Methylene Chloride	28	2	2	5	MCL (5), PRG <sup>(6)</sup>
Naphthalene	28	3	3	41	PRG
<i>n</i> -Propylbenzene	28	1	1	1	PRG <sup>(5)</sup>
Tetrachloroethene	28	11	11	938	MCL (5), PRG <sup>(4)</sup>
Trichloroethene	28	10	14	230	MCL (5), PRG <sup>(4)</sup>
1,2,4-Trimethylbenzene	28	2	2	13	PRG <sup>(7)</sup>
1,3,5-Trimethylbenzene	28	1	1	4	PRG <sup>(5)</sup>
Vinyl Chloride	28	12	12	39	MCL (2), PRG <sup>(4)</sup>
<b>Semivolatile Organic Compounds (μg/kg)</b>					
Bis (2-ethylhexyl)phthalate	28	1	1	14.6	PRG
<b>Pesticides (μg/kg)</b>					
alpha-BHC	10	2	2	0.17	PRG
beta-BHC	10	3	3	0.83	PRG
<b>Dioxins and Furans (ng/kg)</b>					
2,3,7,8-TCDD Equivalent	10	12	2	0.000740	PRG

Notes

- (1) "PRG" refers to US EPA Region 9 Preliminary Remediation Goals (Nov. 11, 2000) for tap water.
- (2) Detection is above 1/10 PRG and was forwarded into Baseline Risk Assessment for consideration.
- (3) The max detection was >MCL, the 3 others > PRG.
- (4) All detections marked "above standard" were >MCL and >PRG.
- (5) The max detection was above the 1/10th PRG comparison used for noncarcinogenic contaminants.
- (6) The max detection was >MCL and >PRG.
- (7) Of the 2 detections marked "above standard" one was >PRG and 1 was >1/10 PRG.

### E.2.3 Surface Water

Table E-3 highlights surface water detections. In general, the surface water results do not indicate a significant problem. Phase I RI sample results included elevated levels of three inorganic constituents and dioxin. Dioxin was present in two samples above background and above water quality criteria, but considering a background detection, it is not clear that the Site is the origin. Iron and aluminum were also detected at levels above Federal and State surface water quality standards; however, a clear Site origin could not be established.

The VOC detections shown in Table E-3 are from samples collected as part of the Phase II investigation of groundwater and Fairforest Creek. Individual VOC levels ranged between 1 and 10  $\mu\text{g/l}$ . As shown, two of these surface water detections (TCE and PCE) equal or exceed the State and Federal surface water quality standard.

### E.2.4 Sediment

Sediment sample results are included in Table E-3. Three inorganic substances and one organic chemical, dioxin, were detected but cannot be attributed with certainty to the Site. One organic chemical, p/p-xylene, was detected in one sample at 16  $\mu\text{g/kg}$ .

### E.2.5 Landfill Gas

Landfill gas samples (Table E-4) contained a large number of organic compounds at very low levels. The data for 20 organic compounds were forwarded for consideration in the Baseline Risk Assessment.

## E.3 Conceptual Site Model

Figure E-5 presents the Conceptual Site Model, a diagram illustrating the key components of the present environmental situation. Components include the primary source(s), which is the origin of the hazardous substances present at a site; the release mechanism or means by which the contaminant gets into the environment; any secondary sources and their release mechanisms; the pathway, usually a medium such as soil or groundwater, along which contaminants move; an exposure route or means of entry into the body; and finally one or more receptors, the people or animals that are exposed to the chemicals of concern.

At the Arkwright Dump Site, the primary source of contaminants is the waste within the landfill, primarily located in the vadose (unsaturated) zone above the water table. Biodegradation and volatilization release the chemicals of concern (COCs) into soil gas (landfill gas), which eventually releases into the ambient air above the ground surface. Exposure could occur from inhaling these vapors. Leaching from the waste, primarily from the action of rainwater percolating through it, contaminates the underlying deep soil and eventually brings the COCs into groundwater.

**TABLE E-3**  
**Surface Water and Sediment Sample Results**

<b>Surface Water</b>					
<b>Chemical</b>	<b>No. Samples</b>	<b>No. Detections</b>	<b>No. above Standard</b>	<b>Maximum Detected</b>	<b>Comparison Standard Exceeded</b>
<b>Inorganics (mg/kg)</b>					
Aluminum	7	7	1	0.95	2x Bkgd, R4 Ecol <sup>(1)</sup>
Iron	7	7	1	1.0	2x Bkgd, R4 Ecol
Manganese	7	7	6	0.16	2x Bkgd
<b>Organic Compounds (µg/kg)</b>					
cis-1,2-Dichloroethene	13	6	-	10	(Detected)
Tetrachloroethene	13	2	1	2.0	RWQC - HH (org) <sup>(2)</sup>
Trichloroethene	13	1	1	2.0	RWQC - HH (org) <sup>(2)</sup>
Vinyl Chloride	13	1	-	1.0	(Detected)
<b>Dioxins and Furans (ng/kg)</b>					
2,3,7,8-TCDD Equivalent	7	3	2	0.00014	RWQC - HH (org) <sup>(2)</sup>

<b>Sediment</b>					
<b>Chemical</b>	<b>No. Samples</b>	<b>No. Detections</b>	<b>No. above Standard</b>	<b>Maximum Detected</b>	<b>Comparison Standard Exceeded</b>
<b>Inorganics (mg/kg)</b>					
Arsenic	6	4	1	5.2 <sup>(3)</sup>	2x Bkgd
Iron	6	6	1	19,000 <sup>(3)</sup>	2x Bkgd
<b>Organic Compounds (µg/kg)</b>					
m/p-Xylene	6	2	-	16	(Detected)
<b>Dioxins and Furans (ng/kg)</b>					
2,3,7,8-TCDD Equivalent	6	6	(Note 4)	1.01	(Detected)

Notes

"Bkgd" = background.

- (1) "R4 Ecol" refers to US EPA Region 4 Ecological Screening Values, for both Surface Water ("Freshwater") and Sediment. Posted at <http://www.epa.gov/region4/waste/ots/ecolbul.htm#tbl3>
- (2) "RWQC - HH (org)" refers to the *National Recommended Quality Criteria - Correction*, US EPA Publication 822-Z-99-001, April 1999 (57 FR 60848), and SC Regulation 61-68, Water Classifications and Standards, amended 6/22/01: Protection of Human Health, number for consumption of water & organism..
- (3) These maxima were detected at SD-04, slightly upstream of the property boundary, and are likely not attributable to the Site.
- (4) The background detection, upstream of the Site, was at the EPA Region 4 screening value (2.5 ng/kg). The Site maximum detected was 1.01 ng/kg, as shown.

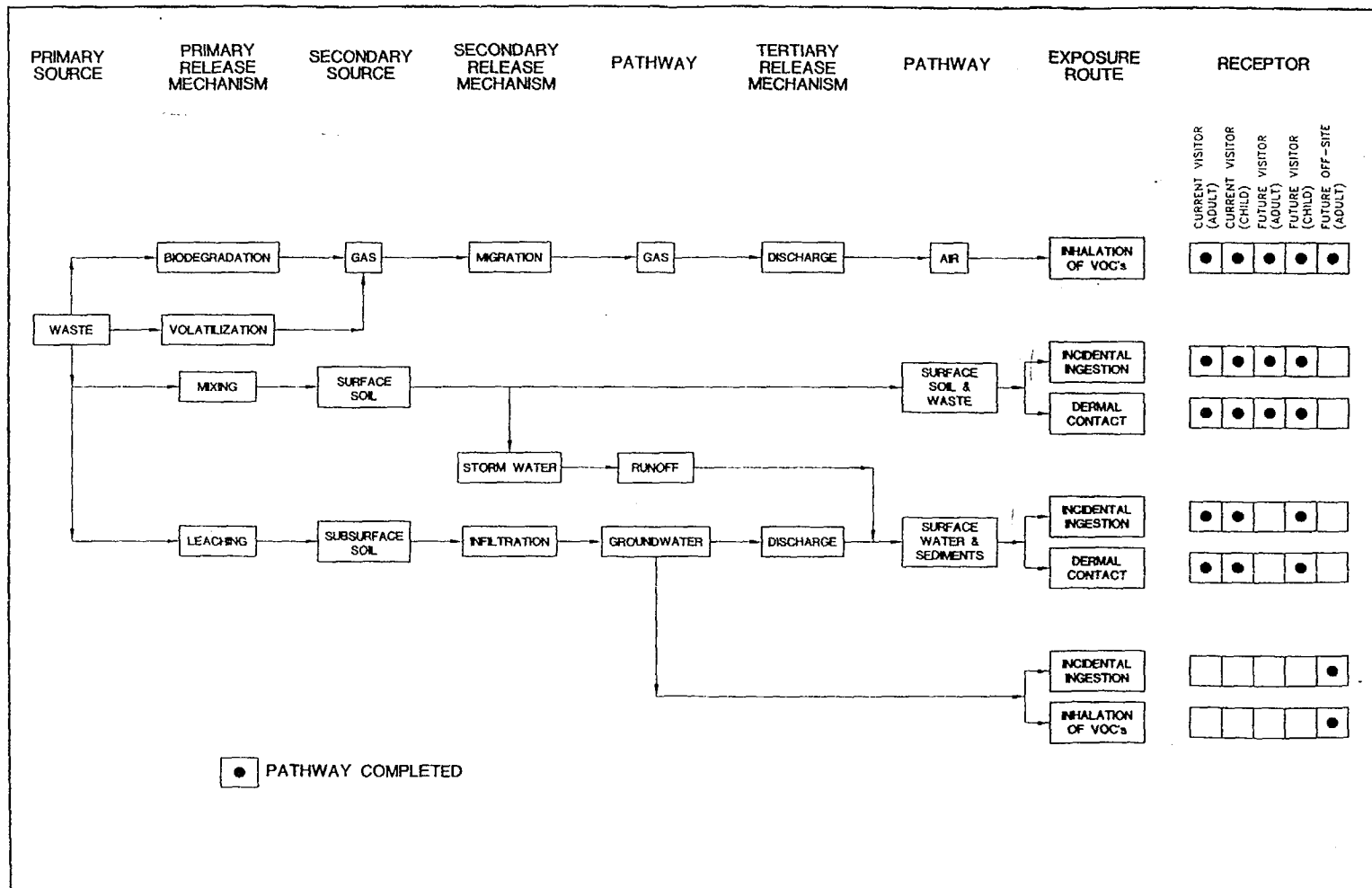
TABLE E-4  
Landfill Gas Sample Results

Chemical	No. Samples	No. Detections	No. above PRG <sup>(1)</sup>	Maximum Detected
Volatile Organic Compounds (ppbv)				
Benzene	15	7	7	9,500
Chlorobenzene	15	7	7	2,500
Chloroform	15	-	-	ND <sup>(2)</sup>
Cryoflourane (Freon 114)	15	13	(Note 3)	430
<i>p</i> -Dichlorobenzene	15	6	6	520
Dichlorodiflouromethane	15	13	10	420
<i>cis</i> -1,2-Dichloroethene	15	5	2	150
Ethylbenzene	15	5	1	990
Ethyl chloride	15	1	1	15
Methyl chloride	15	2	2	200
Methylene chloride	15	2	2	14
Tetrachloroethene	15	10	10	130
Toluene	15	2	1	150
Trichloroethene	15	2	2	1,600
Trichloroflouromethane	15	10	2	38
1,2,4-Trimethylbenzene	15	10	9	1,900 <sup>(2)</sup>
1,3,5-Trimethylbenzene	15	5	3	660 <sup>(2)</sup>
Vinyl Chloride	15	5	5	750
<i>m/p</i> -Xylene	15	4	1	2,300
<i>o</i> -Xylene	15	6	1	350

## Notes

- (1) "PRG" = US EPA Region 9 Preliminary Remediation Goal for ambient air.  
 (2) Detection was in background sample. Not detected at Site.  
 (3) No PRG established.

**FIGURE E-5**  
**Conceptual Site Model**



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Evidence to date indicates the COCs move with groundwater until they discharge to Fairforest Creek. Exposure to the creek water and sediments, through wading in the creek and direct contact with both water and sediment, are possible exposure routes. In a possible future use scenario, groundwater could be used as a potable water source, so that exposure could occur through ingesting the water or inhaling vapors from it.

## **F. CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES**

### **F.1 Land Use**

Spartanburg County controls land usage but does not use zoning ordinances. Thus the Site property is not zoned for any particular type of usage. No development or other Site use has occurred since the landfill closed in 1972. The property was purchased from City in 1976 by a local citizen, who transferred ownership to his son in 1996. Observations during EPA Site Assessment work, and discussion with local residents, indicated that children play on the dump property, and that adults cross the property on foot. Evidence of target shooting was observed.

Current land use around the site is mixed. Residential areas are located south and west of the Site, as well as to the east across Fairforest Creek. Active industrial plants nearby include Rhodia Division of Rhone-Poulenc, Arkwright Mill, and a Zupan concrete production facility. Other uses within 1/2-mile include auto repair and salvage yards, churches, offices, and convenience stores.

The expected future land use for the Site and surrounding areas is undetermined at present. Dialogue with representatives of the County, City, and the community group Re-Genesis (see Section C) indicates a clear preference for recreational use of the Site property once the remedy is in place. The types of activities they envision include a "Greenway Space" along Fairforest Creek that would connect to other belts or trails, bicycle trails, and open grassed fields for informal sports or outdoor-fair-type events:

In addition to the current situation of homes and industrial facilities in close proximity, one of the community's concerns is a lack of nearby retail businesses such as grocery stores and pharmacies. There is also a community perception that local development and growth is occurring elsewhere in the area, but passing the "southside" by. The momentum, size and scope of the ongoing "Regenesis Project," and the number of project partners and stakeholders, seem likely to bring about a wider range of land uses (retail, shopping, light commercial) on nearby properties in the future.

## F.2 Groundwater Use

Groundwater is not used at the Site, but nearby private water wells within 1/4-mile are in use for non-potable uses such as irrigating lawns and gardens, and washing cars. EPA connected the only two known nearby water well users to the Spartanburg Water System in 1999; no other wells for potable water supply are known to exist within 1/4-mile of the Site. Within one mile, 51 persons are estimated to use groundwater for their potable water source. The vast majority of nearby water use is supplied by the Spartanburg Water System, which obtains water from nearby Lake Bowen and from the South Pacolet River. However, the State of South Carolina and EPA groundwater classifications for the area indicate that groundwater from the aquifer system is considered a current and potential future source of drinking water.

## G. SUMMARY OF SITE RISKS

### G.1 Summary of Human Health Risk Assessment

The baseline risk assessment estimates what risks the Site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the Baseline Risk Assessment for this site.

Although EPA Presumptive Remedy Guidance allows for streamlining of the Baseline Risk Assessment, the presence of numerous pathways other than soil contact (such as sediment and water contact, and potential groundwater use) led to the generation of a full quantitative assessment.

#### G.1.1 Chemicals of Potential Concern

Table G-1 presents the chemicals of potential concern (COPCs) detected in each medium, and the exposure point concentration for each (which was used to estimate the exposure and risk from each COPC). The table includes the range of concentrations detected for each COPC, the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the Site), the exposure point concentration, and how each exposure point concentration was derived. In all cases, the maximum detection was used as the default EPC in view of limited site data. The PCOCs represent those chemicals remaining after RI detections were screened against (1) average background concentration and 2) health-risk-based screening values. For all COPCs, quantitative risk calculations were performed to generate numerical risk estimates.

### Current and Future Use - Site Visitor

**Medium:** Soil

Units: mg/kg

**Exposure Medium:** Surface Soil

Exposure Point	Chemical of Concern	Detected Concentration		Detection Frequency <sup>1</sup>	Exposure Point Concentration	Statistical Measure
		Minimum	Maximum			
Landfill surface soil	Arsenic	2.4	12	6/6	12	Max
	Benzo(a)pyrene (Equivalent)	0.62	0.62	1/17	0.736 (Note 2)	Max
	2,3,7,8-TCDD TEQ	0.00000148	0.000404	7/117	0.000404	Max
	4, 4'-DDT	0.01	0.0276	2/17	0.0276	Max
	4, 4'-DDE	0.01	0.01	2/17	0.01	Max

### Future Use - Offsite Resident

Medium: Water

Units:  $\mu\text{g/L}$ 

**Exposure Medium:** Groundwater

Ground-water	Concentration (mg/L)	Concentration (mg/L)	Concentration (mg/L)	Concentration (mg/L)	Concentration (mg/L)
Arsenic	5	5	1/17	5	Max
Barium	64	520	13/17	520	Max
Chromium	9.3	27	7/17	27	Max
Iron	51	39,000	15/17	39,000	Max
Manganese	5.6	5,300	17/17	5,300	Max
Benzene	1	50	8/28	50	Max
Chlorobenzene	2.6	17	11/28	17	Max
Chloroform	1.8	1.8	1/28	1.8	Max
1,1-Dichloroethene	4.4	7.3	4/28	7.3	Max
Cis-1,2-Dichloroethene	7	290	17/28	290	Max
Trans-1,2-Dichloroethene	1.3	27	8/28	27	Max
Methylene Chloride	1.0	5	2/28	5	Max
Naphthalene	2	41	3/28	41	Max
n-Propylbenzene	8	8	1/28	8	Max
Tetrachloroethene	1.1	938	11/28	938	Max
Trichloroethene	3.5	230	10/28	230	Max
1,2,4-Trimethylbenzene	3	13	2/28	13	Max
1,3,5-Trimethylbenzene	4	4	1/28	4	Max
Vinyl Chloride	2	39	10/28	39	Max
o-xylene	1.5	3	12/28	3	Max
m/p-xylene	2	5	4/28	5	Max
alpha-BHC	0.16	0.17	2/10	0.17	Max
beta-BHC	0.28	0.83	3/10	0.83	Max
PCB (Arochlor 1242)	1.45	1.45	1/24	1.45	Max
2,3,7,8-TCDD Equivalent	$4 \times 10^{-4}$	$7.4 \times 10^{-4}$	12/24	$7.4 \times 10^{-4}$ (Note 3)	Max

**Notes:**

This table shows the PCOCs for the significant (risk-causing) media and pathways at the Site. Additional pathways were evaluated in the Baseline Risk Assessment.

Max - Exposure point concentrations are based on the maximum detected concentrations.

ND - not detected.

(1) Detection frequency is based upon temporary wells and permanent wells; since Phase 2 samples repeat some wells, detection in either phase counts as one detection.

(2) Although 0.62 was the max detection of BAP, other closely-related PAH detections were added to give an "Equivalent" value (EPA Guidance)

(3) The detected concentration, in nanograms, is 0.00074.

### G.1.2 Exposure Assessment

The exposure assessment identified potential exposure pathways and quantifies the magnitude, frequency and duration of reasonable maximum exposure. Based on the expected future Site use and on the Site Conceptual Model (Section E-3), the Baseline Risk Assessment developed the following current use and future use scenarios in evaluating Site risks:

#### Current Site use:

- Exposures to COPCs by an adult Site visitor, who is onsite periodically for recreational purposes. The two exposure pathways through which the adult would be exposed to contaminants are contact with surface soil, and breathing vapors from Site COPCs in landfill gas.
- Exposures to COPCs by an adolescent child (age 7-12) Site visitor. The child has similar exposure as the adult, but also contacts surface water and sediment while playing in Fairforest Creek.
- Exposures to COPCs by a small child (age 1-6) Site visitor. The child is assumed to be supervised and thus to have only similar exposure to the adult.

#### Future Site use:

- Exposures to COPCs by adult, adolescent child, and small child Site visitors. These are the same as the three listed above.
- Exposures to COPCs in the groundwater by an adult offsite resident, from groundwater use as the potable water source.
- Exposures to COPCs in the groundwater by an adolescent child (age 7-12) offsite resident, from groundwater use as the potable water source.
- Exposures to COPCs in the groundwater by a small child (age 1-6) offsite resident, from groundwater use as the potable water source.

Persons who could be exposed to Site COPCs are referred to as "receptors." The assumptions and specific exposure factors (magnitude, frequency and duration of exposure, averaged exposure doses) are presented in Appendix B.

### G.1.3 Toxicity Assessment

The toxicity assessment addresses the potential for a COPC to cause adverse effects in exposed populations (in this case, Site visitors or offsite residents using groundwater) and estimates the

dose-response relationship, which is the relationship between extent of exposure, and extent of toxic injury. To assist in estimating the potential health effects, EPA has developed toxicity values which reflect the magnitude of the adverse noncarcinogenic and carcinogenic effects from exposure to specific chemicals.

Health effects caused by exposure to chemicals can be divided into two general types:

1) carcinogenic effects, which elevate the risk of a gene mutation or of a person developing cancer, and 2) noncarcinogenic effects, which involve damage to, or impairment of, various organ systems of the human body. In the two subsections which follow, brief descriptions of the development of the toxicity values for each type of effect (carcinogenic and non-carcinogenic) are provided.

#### G.1.3.1 *Noncarcinogenic effects*

Table G-2 provides the noncarcinogenic toxicity data used in the Baseline Risk Assessment. General information about the development and selection of these values is presented below.

Chemicals that cause non-carcinogenic effects are often referred to as "systemic toxicants" because of their effects on the function of various organ systems. For many noncarcinogenic effects, protective mechanisms (i.e., exposure or dose thresholds ) are believed to exist that must be overcome before adverse effects occur. This fact distinguishes systemic toxicants from carcinogens and mutagens, which are often treated as acting without a distinct threshold. As a result, for noncarcinogens there is some finite amount of exposure that can be tolerated with almost no chance of adverse effects occurring. The standard approach for developing toxicity values is to identify the upper bound of this tolerance range, which can be called a threshold, and to establish the toxicity values based on the threshold.

The toxicity value most often used in evaluating noncarcinogenic effects is a Reference Dose (RfD) for oral exposure (ingestion) or dermal exposure (skin contact), or Reference Concentration (RfC) for inhalation exposure. Various types of RfDs/RfCs are available, depending on (1) the exposure route of concern (e.g., oral or inhalation), (2) the critical effect of the chemical (e.g., developmental or other), and (3) the length of exposure being evaluated (e.g., chronic or subchronic).

Reference Doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals that exhibit noncarcinogenic effects. A chronic RfD or RfC is defined as an estimate of a daily exposure level that is likely to generate no appreciable risk of negative effects during a lifetime. RfDs, which are expressed in units of mg/kg-day, are

**TABLE G-2**  
**Noncarcinogenic Toxicity Data Summary**

**MEDIUM: SOIL (Current and Future Use - Site Visitor)**  
**Pathways: Soil contact (incidental ingestion, absorption)**

Chemical of Potential Concern	Oral RfD <sub>o</sub> Reference Dose mg/kg-day	Source	Absorption RfD <sub>a</sub> Reference Dose mg/kg-day	Source
Manganese	2.40E-02	IRIS	9.60E-04	IRIS Abs - 0.040 [ASTDR]
Antimony	4.00E-04	IRIS	4.00E-04	IRIS
Arsenic	3.00E-04	IRIS	3.00E-04	IRIS
Barium	7.00E-02	IRIS	7.00E-02	IRIS
Cadmium	5.00E-04	IRIS	1.25E-05	IRIS Abs - 0.025 [RAGS (Pt E) ]
Copper	3.70E-02	IRIS	3.70E-02	IRIS
Cyanide	2.00E-02	IRIS	2.00E-02	IRIS
Selenium	7.00E-05	IRIS	3.85E-05	IRIS Abs - 0.55 [RAGS (Pt E) Mid-point of range (30-80%). ]
Zinc	3.00E-01	IRIS	3.00E-01	IRIS
Dieldrin	5.00E-05	IRIS	5.00E-05	IRIS
4,4'-DDT	5.00E-04	IRIS	5.00E-04	IRIS

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TABLE G-2  
 Noncarcinogenic Toxicity Data Summary (continued)

**MEDIUM: GROUNDWATER (Future Use - Offsite Resident)**

**Pathway: Groundwater use (well water ingestion, inhalation and absorption while showering)**

Chemical of Potential Concern	US EPA Classification	Oral SF <sub>o</sub> Slope Factor (kg day)/mg	Source	Inhalation SF <sub>i</sub> Slope Factor (kg day)/mg	Source	Dermal SF <sub>d</sub> Slope Factor (kg day)/mg	Source
Arsenic	A	1.5	IRIS	NA	-	1.5	Extrapolated
Benzene	A	0.055	IRIS	0.027	Extrapolated	0.055	Extrapolated
Chloroform	B2	0.0061	IRIS	0.081	IRIS	0.0061	Extrapolated
p-Dichlorobenzene	C	0.024	HEAST	0.024	Extrapolated	0.024	Extrapolated
1,1-Dichloroethene	C	0.6	IRIS	0.18	IRIS	0.6	Extrapolated
Methylene chloride	B2	0.0075	IRIS	0.0016	IRIS	0.0075	Extrapolated
Tetrachloroethene	B2	0.052	EPA Prov.	0.002	NCEA	0.052	Extrapolated
Trichloroethene	B2	0.011	EPA Prov.	0.006	NCEA	0.011	Extrapolated
Vinyl chloride	A	1.5	IRIS	0.03	IRIS	1.5	Extrapolated
Bis(2-ethylhexyl) phthalate	B2	0.014	IRIS	0.014	Extrapolated	0.014	Extrapolated
Aroclor (PCB) 1242	B2	1.0 <sup>a</sup>	IRIS	1.0	Extrapolated	1.0	Extrapolated
alpha-BHC	B2	6.3	IRIS	6.3	Extrapolated	6.3	Extrapolated
beta-BHC	B2	1.8	IRIS	1.8	Extrapolated	1.8	Extrapolated
2,3,7,8-TCDD Equivalents	B2	150,000	HEAST	NA	-	150,000	Extrapolated

NA - Not applicable due to volatility.

<sup>a</sup> Central estimate slope factor for high risk and persistence. Applicable to soil and water ingestion.

estimates of lifetime daily exposure limits for humans, including sensitive individuals (for example, children). Estimated intakes of contaminants of concern from environmental media (for example, the amount of a contaminant of concern ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (often to account for the use of animal data to predict effects on humans). Chronic RfDs/RfCs are specifically developed to be protective for long-term exposures, i.e., seven (7) years to a lifetime (70 years). In the Site Baseline Risk Assessment, exposures other than childhood exposures are assumed to be long-term. Child visitors age 7-12 years, and small child visitors age 1-6 years, are 6-year exposure durations in accordance with the Risk Assessment Guidance for Superfund (RAGS). The sources for the chronic RfDs and RfCs for the COPCs at this Site include EPA's Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Tables (HEAST).

#### G.1.3.2 *Carcinogenic effects*

Table G-3 provides the carcinogenic toxicity data used in the Baseline Risk Assessment. General information about the development and selection of these values is presented below.

Unlike many noncarcinogenic health effects, cancer is believed to originate from a non-threshold effect. Such a "non-threshold" characteristic means that there is essentially no level of exposure that does not pose a some finite possibility of generating cancer growth. Some carcinogenic chemicals can also exhibit systemic toxicity effects.

To evaluate carcinogenic effects, EPA uses a two-part evaluation. First the chemical is assigned a weight-of-evidence classification, followed by calculation of a Carcinogenic Slope Factor (CSF). The CSF can be derived for either oral or inhalation exposures.

TABLE G-3  
Carcinogenic Toxicity Data Summary

**MEDIUM: SOIL (Current and Future Use - Site Visitor)**

Pathways: Soil contact (incidental ingestion, absorption)

Chemical of Potential Concern	US EPA CLASS	Oral SF <sub>0</sub> Slope Factor kg-day/kg	Source	Absorption SF <sub>d</sub> Slope Factor kg-day/kg	Source
Arsenic	A	1.50E+00	IRIS	1.50E+00	IRIS
2,3,7,8-TCDD Equivalents	B2	1.50E+05	HEAST	1.50E+05	HEAST
Benzo(a)pyrene Equivalents	B2	7.35E+00	IRIS	7.35E+00	IRIS
4,4'-DDT	B2	3.40E-01	IRIS	3.40E-01	IRIS
4,4'-DDE	B2	3.40E-01	IRIS	3.40E-01	IRIS

**MEDIUM: GROUNDWATER (Future Use - Offsite Resident)**

Pathway: Groundwater use (well water ingestion, inhalation and absorption while showering)

Chemical of Potential Concern	US EPA Classification	Oral SF <sub>0</sub> Slope Factor (kg day)/mg	Source	Inhalation SF <sub>i</sub> Slope Factor (kg day)/mg	Source	Dermal SF <sub>d</sub> Slope Factor (kg day)/mg	Source
Arsenic	A	1.5	IRIS	NA	-	1.5	Extrapolated
Benzene	A	0.055	IRIS	0.027	Extrapolated	0.055	Extrapolated
Chloroform	B2	0.0061	IRIS	0.081	IRIS	0.0061	Extrapolated
p-Dichlorobenzene	C	0.024	HEAST	0.024	Extrapolated	0.024	Extrapolated
1,1-Dichloroethene	C	0.6	IRIS	0.18	IRIS	0.6	Extrapolated
Methylene chloride	B2	0.0075	IRIS	0.0016	IRIS	0.0075	Extrapolated
Tetrachloroethene	B2	0.052	EPA Prov.	0.002	NCEA.	0.052	Extrapolated
Trichloroethene	B2	0.011	EPA Prov.	0.006	NCEA	0.011	Extrapolated
Vinyl chloride	A	1.5	IRIS	0.03	IRIS	1.5	Extrapolated
Bis(2-ethylhexyl) phthalate	B2	0.014	IRIS	0.014	Extrapolated	0.014	Extrapolated
Aroclor (PCB) 1242	B2	1.0 <sup>a</sup>	IRIS	1.0	Extrapolated	1.0	Extrapolated
alpha-BHC	B2	6.3	IRIS	6.3	Extrapolated	6.3	Extrapolated
beta-BHC	B2	1.8	IRIS	1.8	Extrapolated	1.8	Extrapolated
2,3,7,8-TCDD Equivalents	B2	150,000	HEAST	NA	-	150,000	Extrapolated

NA - Not applicable due to volatility.

<sup>a</sup> Central estimate slope factor for high risk and persistence. Applicable to soil and water ingestion.

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The weight-of-evidence classification is based upon an evaluation of the available data to determine the likelihood that the chemical is a human carcinogen. The following list shows the EPA cancer classes with an explanation of each (based on the EPA 1986 Cancer Guidelines).

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USEPA Weight-of-Evidence  
Classification System for Carcinogenicity

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Group	Description
A	Human carcinogen
B	Probable human carcinogen
B1	Limited data are available
B2	Sufficient evidence in animals; inadequate or no evidence in humans
C	Possible human carcinogen
D	Not classifiable as to human carcinogenicity
E	Evidence of noncarcinogenicity for humans

The CSF quantitatively defines the relationship between the dose and the response. SFs have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals of concern. The CSFs, which are expressed in units of  $(\text{mg/kg-day})^{-1}$ , are multiplied by the estimated intake of a potential carcinogen, in  $\text{mg/kg-day}$ , to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The Slope Factor is generally expressed as a plausible upper-bound estimate of the probability of response occurring per unit of chemical. The term "upper-bound" reflects the conservative estimate of the risks calculated from the CSF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Carcinogenic Slope Factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-animal extrapolation and uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). The Carcinogenic Slope Factors for the chemicals of concern at this Site (Table G-3) were obtained from EPA's Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Tables (HEAST).

It should be noted that no RfDs or CSFs have been derived for dermal absorption, the process by which chemicals move across the skin barrier and into the body. Risks from dermal exposures are evaluated using Oral Absorbed Dose RfDs or Oral Absorbed Slope Factors after dermal exposures are converted to their respective absorbed dose. Dermal exposures were adjusted to absorbed dose estimates by assuming that the contaminants permeate skin at chemical-specific permeability rates. Oral RfDs and CSFs were also adjusted by the appropriate oral absorption rate, which gives an Absorbed Dose RfD or Absorbed Dose CSF. The Dermal Absorbed Dose intakes can then be compared to Absorbed Dose toxicity values, as described in the Risk Assessment Guidance for Superfund (RAGS).

#### G.1.4 Risk Characterization

The final step in the risk assessment process is the numerical calculation of estimated risk. Table G-4 presents a summary table of the total carcinogenic and noncarcinogenic risks posed by the Arkwright Dump Site. At this stage of risk assessment, the risk calculations include determination of which chemicals actually cause Site risks. These chemicals are referred to as "Contaminants of Concern" (COCs). Appendix B provides the detailed risk calculations for the COCs in the significant (risk-causing) exposure pathways.

As shown in Table G-4, the Site presents long-term risks to human health under both current-use and future-use scenarios. Under both current- and anticipated future-use conditions, the Site property (landfill) presents an estimated total carcinogenic risk level of  $1.57 \times 10^{-5}$  to Site visitors, which exceeds EPA's "point of departure" of  $1 \times 10^{-6}$  (see discussion below). The carcinogenic risk derives from contact with contaminated soils (dermal absorption, incidental ingestion). The main COCs are dioxins, arsenic, benzo(a)pyrene, and 4,4'-DDE. Under the future use scenario, noncarcinogenic risk is indicated by Hazard Index (HI) values between 142 and 360 for offsite residents who use Site-contaminated groundwater (ingestion, showering, vapor inhalation) as potable water. Carcinogenic risk for the offsite residents is  $7.3 \times 10^{-3}$ , which is above the maximum end of the acceptable risk range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ . The COCs responsible for risk are the VOCs, primarily tetrachloroethene, trichloroethene, 1,1-DCE, and vinyl chloride.

The following paragraphs provide general explanations of the risk numbers, the manner in which they are generated, and EPA's interpretation of the risk results under CERCLA and the NCP. Section G.1.4.2 discusses sources of uncertainty in the calculation of risk estimates.

For chemicals whose effects are carcinogenic, quantifying the risk is done by an additive process that intended to account for a "worst case" scenario, where a person could be exposed through several or all of the possible exposure pathways. Thus, for each exposure pathway (ingestion, inhalation etc.), the cancer risk from each individual contaminant is added together. For each exposure scenario (current use, future use) that has more than one pathway of exposure, all of the pathways are added together to give a "reasonable maximum exposure." The result is expressed as the excess (that is, Site-caused) cancer risk posed by Site contaminants.

The NCP establishes a range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  as the accepted range for setting, within this range, a limit on lifetime excess carcinogenic risks due to a site. Excess (Site-caused) risk in this range means that between one person in 10,000 ( $1 \times 10^{-4}$ ) and one person in one million ( $1 \times 10^{-6}$ ) will risk developing cancer during a lifetime of exposure. In accordance with the NCP, EPA strives to achieve a  $1 \times 10^{-6}$  excess risk level where possible. If the total carcinogenic risk at a site is above this level, by law, EPA can require that remedial actions be undertaken to eliminate or reduce risks.

Noncarcinogenic effects are evaluated by comparing an exposure level over a specified time period (e.g., a lifetime) with a reference dose (RfD) derived for a similar exposure period.

**TABLE G-4**  
**Summary of Human Health Risks**

Receptors	Hazard Index	Carcinogenic Risk	Primary Source - Pathways	Primary Constituents
<b>Current Land Use</b>				
Adult Site Visitor	<1	1.57 E-05 <sup>(1)</sup>	<u>Surface Soil</u> - dermal contact and incidental ingestion	Dioxin, arsenic, benzo(a)pyrene, 4,4'-DDE
<b>Future Land Use</b>				
Adult Site Visitor	<1	1.57 E-05 <sup>(1)</sup>	<u>Surface Soil</u> - dermal contact and incidental ingestion	Dioxin, arsenic, benzo(a)pyrene, 4,4'-DDE
Offsite Adult Resident	142	7.25 E-03 <sup>(1)</sup>	<u>Groundwater</u> - ingestion of groundwater, inhalation of VOCs and absorption of VOCs during showering	Tetrachloroethene, 1,1-DCE, vinyl chloride, trichloroethene
Offsite Child Resident (Age 7-12)	222	7.25 E-03 <sup>(2)</sup>	<u>Groundwater</u> - ingestion of groundwater, inhalation of VOCs and absorption of VOCs during showering	Tetrachloroethene, 1,1-DCE, vinyl chloride, trichloroethene
Offsite Child Resident (Age 1-6)	360	7.25 E-03 <sup>(1)</sup>	<u>Groundwater</u> - ingestion of groundwater, inhalation of VOCs and absorption of VOCs during showering	Tetrachloroethene, 1,1-DCE, vinyl chloride, trichloroethene

Notes

(1) Exposure duration = lifetime.

(2) Exposure duration = lifetime. Exposures are presumed to occur beginning as older child (7-12).

An RfD represents a level that an individual may be exposed to that is not expected to cause any negative effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ < 1.0 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. A summary figure, the Hazard Index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g., liver), or that act through the same mechanism of action within a medium (or across all media) to which a given individual may reasonably be exposed. To obtain a "reasonable maximum exposure," the HQs for all contaminant(s) of concern that effect the same target organ (e.g., liver) within a medium, or across all media, to which a given population may reasonably be exposed are added together to generate the HI. An HI < 1.0 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI > 1.0 indicates that Site-related exposures may present a risk to human health. EPA generally requires that remedial actions be taken at sites which have a current-use or future-use HI that is greater than 1.0.

#### G.1.4.1 Final Site Contaminants of Concern (COCs)

As noted above, the risk calculations allow determination of which chemicals actually cause risks, i.e. have HIS > 1.0 or carcinogenic risk >  $1 \times 10^{-6}$ . These chemicals, the Final Site COCs, are presented in Table G-5.

#### G.1.4.2 Uncertainty Analysis

There are sources of uncertainty in the Baseline Risk assessment. One source is the limited size of the data set obtained in the RI, which is assumed to be representative of Site conditions. Typically, the issue is that this leads to an overestimation of risk, but on a landfill surface with many locations of visible waste and little cover, EPA believes risks from soil are not necessarily overestimated. Exposure parameters used in developing Reasonable maximum Exposure (RME) scenarios involve upper-bound values which are conservative and may lead to overestimation of risk. Among the include toxicity criteria used to estimate risk, cancer slope factors and reference doses (RfDs) both have associated uncertainties that can generate overestimation of risk. In the case of slope factors, the methods for deriving them include extrapolations downward across many orders of magnitude, usually from animal studies involving high doses. Similarly, RfDs are derived from dose-response studies in animals, from which "no observable adverse effects" levels are modified with "uncertainty factors" (which can be orders of magnitude) that assure that they are protective of human health, often because data from chemical toxicity studies is extremely limited.

No significant data usability issues arose in the RI that impacted the characterization of risk in the Baseline Risk Assessment.

**TABLE G-5**  
**Final Site Contaminants of Concern (COCs)**

Medium: Soils (surface)	Medium: Groundwater
Exposure pathways: Dermal absorption, incidental ingestion, inhalation	Exposure pathways: Groundwater ingestion; inhalation and absorption during showering
Arsenic Benzo(a)pyrene Dioxins 4,4'-DDE	Benzene 1,1-Dichloroethylene cis-1,2-Dichloroethylene Naphthalene Tetrachloroethylene Trichloroethylene Vinyl chloride Manganese Chlorobenzene Chloroform 1,3-Dichlorobenzene 1,4-Dichlorobenzene Methylene chloride n-Propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene Dioxins Alpha-BHC Beta-BHC Arsenic Barium Chromium Iron

## G.2 Summary of Ecological Risk Screening Assessment

As part of the RI/FS, the potential for ecological effects from Site contaminants were considered in a Screening Ecological Risk Assessment. EPA and SCDHEC review of the ecological screening indicated that, while there could be some minor degree of ecological impact to Fairforest Creek, the Site cleanup plan will not require a separate action to address ecological concerns. The reasons for this decision are:

- (1) The VOCs present in the creek water at the detected levels do not exceed Region 4 ecological screening values, and are therefore not expected to have a significant ecological impact;
- (2) Detections other than VOCs were not significant; and
- (3) Groundwater actions will be used to reduce or eliminate VOCs in surface water.

## G.3 Basis for Action and Summary

As described in Section G.1.4 and shown in Table G-4, the Site presents long-term risks to human health under both current-use and future-use scenarios. Under both current- and anticipated future-use conditions, the Site presents an estimated total carcinogenic risk of  $1.57 \times 10^{-5}$  to Site visitors, which exceeds EPA's "point of departure" of  $1 \times 10^{-6}$ . Noncarcinogenic risk is indicated by HI values between 142 and 360 for future offsite residents who use Site-contaminated groundwater; carcinogenic risk for the future offsite residents is  $7.25 \times 10^{-3}$ , which is above the maximum end of the acceptable risk range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ .

In view of the Baseline Risk Assessment results, EPA has concluded that actual or threatened releases of hazardous substances from the Site, if not addressed by implementing the response action selected in this Record of Decision, may present a continuing imminent and substantial endangerment to public health, welfare, or the environment. The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

## **H: REMEDIAL ACTION OBJECTIVES**

Under Superfund, the selected remedy for a site must protect human health and the environment, and must meet all of the State and Federal requirements which would apply to such an environmental cleanup action. From this starting point, and with input from the Remedial Investigation Report, the Baseline Risk Assessment and the Ecological Screening Risk Assessment, Site-specific remedial action objectives (RAOs) and Remediation Goals were developed in the Feasibility Study.

### **H.1 Description of RAOs**

By defining what the remedy must accomplish, RAOs serve as a design basis for the various response actions and technology types to be considered for use in cleaning up the Site. They form a basis for comparing choices, since they must be achieved if the cleanup is to be successful.

The RAOs established for the Arkwright Dump Site are the following:

#### **Soil:**

1. Prevent exposure to, or contact with, soil or landfill contents.
2. Reduce or prevent infiltration of rainwater through waste materials so that generation of leachate, and offsite migration of groundwater, are reduced to the greatest degree possible.
3. Control surface water runoff and erosion from the Site.

#### **Groundwater:**

1. Prevent ingestion of groundwater containing contaminant levels above State and Federal MCLs.
2. Reduce or eliminate contaminant concentrations in groundwater moving out from underneath the capped-waste areas, and groundwater which is migrating beyond the property boundaries, in order to restore its potential for productive use as a potable water source.
3. Reduce or eliminate contaminated groundwater discharge to surface water so that there are no exceedances of surface water standards.

### **H.2 Rationale for RAOs and How Each Addresses Risk**

Soil RAOs reflect the basis for employing the Presumptive Remedy at this Site, which is the need to block current and future exposure to long-term risks posed by contact with the landfill wastes. Such action would also control runoff and erosion from the Site into surface water. Action to reduce or eliminate leaching of contamination into groundwater is needed in order to achieve source control on the groundwater contamination, and this would also be accomplished by the Presumptive Remedy of capping.

Groundwater RAOs are intended to both prevent potential human exposure, and to restore all groundwater other than that beneath the capped areas, to its potential beneficial use as a potable water source. Because contaminated groundwater is discharging to surface water, action to reduce the levels of groundwater contamination with VOCs can be expected to reduce, in turn, the levels of VOCs detected in surface water.

In view of this, although surface water is impacted from Site conditions, surface water RAOs were not established. This is based on the very limited degree of impact (one exceedance of a standard) and the fact that any groundwater action would be expected to reduce or eliminate the ongoing groundwater-to-surface water discharge, as described above. Accomplishing the soil and groundwater RAOs will provide appropriate protection for surface water.

At present, potential future use at the Site is undetermined and there are no zoning ordinances or other local restrictions in force that would control or limit its use. The Site Inspection report noted evidence that children were playing on the Site property. The Site is not currently fenced and public access is not physically limited. Therefore, the type of future use scenarios considered in the Baseline Risk Assessment begin with the assumption that the present condition continues; that is, access is not controlled, and there are Site visitors (including children) who cross the Site or visit the Site property at least twice per week during most of the year, excluding three months of winter (no visits).

Because of the uncertainties about future use, the remedy must include the use of institutional controls to limit potential exposure. The most immediate potential, from exposure to landfill contents, will be alleviated once the cap is in place, although some controls will still need to be maintained to protect the integrity of the cap. The specific types of controls to be used will be documented in an "Institutional Controls Plan" as part of the Remedial Design phase of work, to apply to the Remedial Action. Institutional controls are discussed further in Section I.

### H.3 Remedial Goals

The Chemicals of Concern (COCs) from the Baseline Risk Assessment (Table G-5) were used, along with State and Federal requirements, to determine Remediation Goals (RGs) for the Site. These are shown in Table H-1. For the soil medium, individual RGs were not established, as recommended in EPA Guidance (OSWER Directive 9355.0-49FS, Sept. 1993). All areas underlain by wastes, unless the waste is excavated and moved, will be capped, thereby eliminating the need for soil RGs. Capping will prevent exposure and isolate the wastes.

As was approved in the FS, RGs were not established for some of the Final Site COCs. In groundwater, an RG was not established for iron, a nutrient element. There were a number of organic compounds for which the detected maximum was below the applicable MCL and below the noncarcinogenic HQ = 1. These included chlorobenzene, 1,3-dichlorobenzene, and *trans*-1,2-

dichloroethene. Of three organic compounds that do not have MCLs, one, n-propylbenzene, was present in a temporary well at  $HQ < 1$ . The other two organic compounds (two trimethylbenzenes) were only detected in one temporary well but none of the 12 then-existing Phase I permanent wells, and are not significant. Inorganic contaminants with detections below the MCL and  $HQ < 1$  were barium and chromium.

Among the carcinogenic COCs, arsenic and dioxin maximum values were below the MCL. One detection of methylene chloride at the MCL (of 27 samples) is judged not significant enough to warrant an RG. One PCB (Arochlor 1242) detection from one temporary well is likely an artifact associated with suspended sediment, and is not significant. Finally, alpha-BHC and beta-BHC, two pesticides which have no MCLs, were recorded in two wells at  $< 1 \mu\text{g/L}$  each, with corresponding risk levels of between  $1 \times 10^{-5}$  and  $1 \times 10^{-4}$ . These two compounds were also judged not significant enough to warrant an RG.

**TABLE H-1**  
**Remedial Goals**

Groundwater

Chemical of Concern	RG ( $\mu\text{g/L}$ )	Basis
Benzene	5	MCL
1,1-Dichloroethylene	7	MCL
cis-1,2-Dichloroethylene	70	MCL
Naphthalene	20	Baseline Risk Assessment (1)
Tetrachloroethylene	5	MCL
Trichloroethylene	5	MCL
Vinyl chloride	2	MCL
Manganese	880	Baseline Risk Assessment (2)
Notes 1. This level corresponds to a noncarcinogenic risk $HI = 1.0$ . 2. This level corresponds to a noncarcinogenic risk $HI = 1.0$ .		

## I. DESCRIPTION OF ALTERNATIVES

The objective of this section is to provide a brief explanation of the remedial alternatives developed for the Site. In addition to comparing the possible options for capping, the Presumptive Remedy, the Feasibility Study evaluated various technologies that could be used to address contamination in groundwater. Using various combinations of the technologies, seven (7) remedial alternatives were developed. A descriptive summary of each alternative is presented below.

To provide further description, Table I-1 presents a summary of the cost elements, and total costs, of the seven alternatives. The costs shown include "capital costs" and "operations and maintenance (O&M)" costs. Initial up-front construction costs such building a groundwater recovery system or constructing and installing a cap, are capital costs. O&M costs are those necessary to continue the action until cleanup is achieved, based on the estimated time to reach completion. Since these reoccur each year, they are often called "annual O&M costs." Their cost in 2002 dollars, the "net present worth," can be estimated over the total estimated period of the action (30 years) by assuming a discount rate to allow for depreciation. The total of these two types of costs is the "Total Present Worth Cost." A 25% contingency was applied to the capping estimates, and a 15% contingency applied to the groundwater capital costs.

### I.1 Summary Descriptions of Remedial Alternatives

#### Alternative 1 - No Action

- No action other than monitoring of groundwater

Estimated Capital Cost: \$70,000

Est. Total O&M (Annual / 30 yrs): \$40,000 / \$470,000

Est. Total Present Worth Cost: \$540,000

Estimated Time to Reach RAOs: N/A

The No Action Alternative is a baseline for comparison to other alternatives. No remedial actions are taken to address current or future pathways of exposure; reduce landfill contaminants leaching to groundwater; or address contaminated groundwater moving offsite.

It is assumed that monitoring of groundwater would be conducted. The basic program includes periodic sampling for Site COCs (Table H-1) in all existing Site monitoring wells plus one new monitoring well (16 wells total). It is possible the Remedial Design will identify the need for more wells than these. Figure I-1 shows the 16 wells included for monitoring. Monitoring of six (6) surface water stations is also included, to monitor the effects of treatment on the groundwater discharging to Fairforest Creek. Annual sampling events will be performed.

The NCP requires an evaluation of the remedy every five years. Site groundwater monitoring data are used to support the Five-Year Reviews. No other costs are included.

**TABLE I-1**  
**Remedial Alternatives Cost Summary**

Alternative Title		Cost (Million \$)						
		Total Capital-Capping	Total Capital-Groundwater	Annual O&M Cap	Annual O&M Groundwater	Present Worth O&M Cap	Present Worth O&M Groundwater	TOTAL PRESENT WORTH COST
1	No Action	0	0.07	0	0.04	0	0.47	0.53
2	Institutional Controls	0	0.20	0	0.04	0	0.47	0.66
3	FML Cap and Institutional Controls	4.57	0.10	0.06	0.06	0.68	0.47	5.82
4	FML Cap, Institutional Controls and MNA	4.57	0.12	0.06	0.06	0.68	0.71	6.08
5	Soil Cap, Institutional Controls and Groundwater Recovery	3.45	0.31	0.06	0.23	0.68	2.84	7.28
5A	FML Cap, Institutional Controls and Groundwater Recovery	4.57	0.31	0.06	0.18	0.68	2.26	7.82
6	FML Cap, Institutional Controls and Enhanced Biodegradation	4.57	0.29	0.06	0.04	0.68	0.51	6.05

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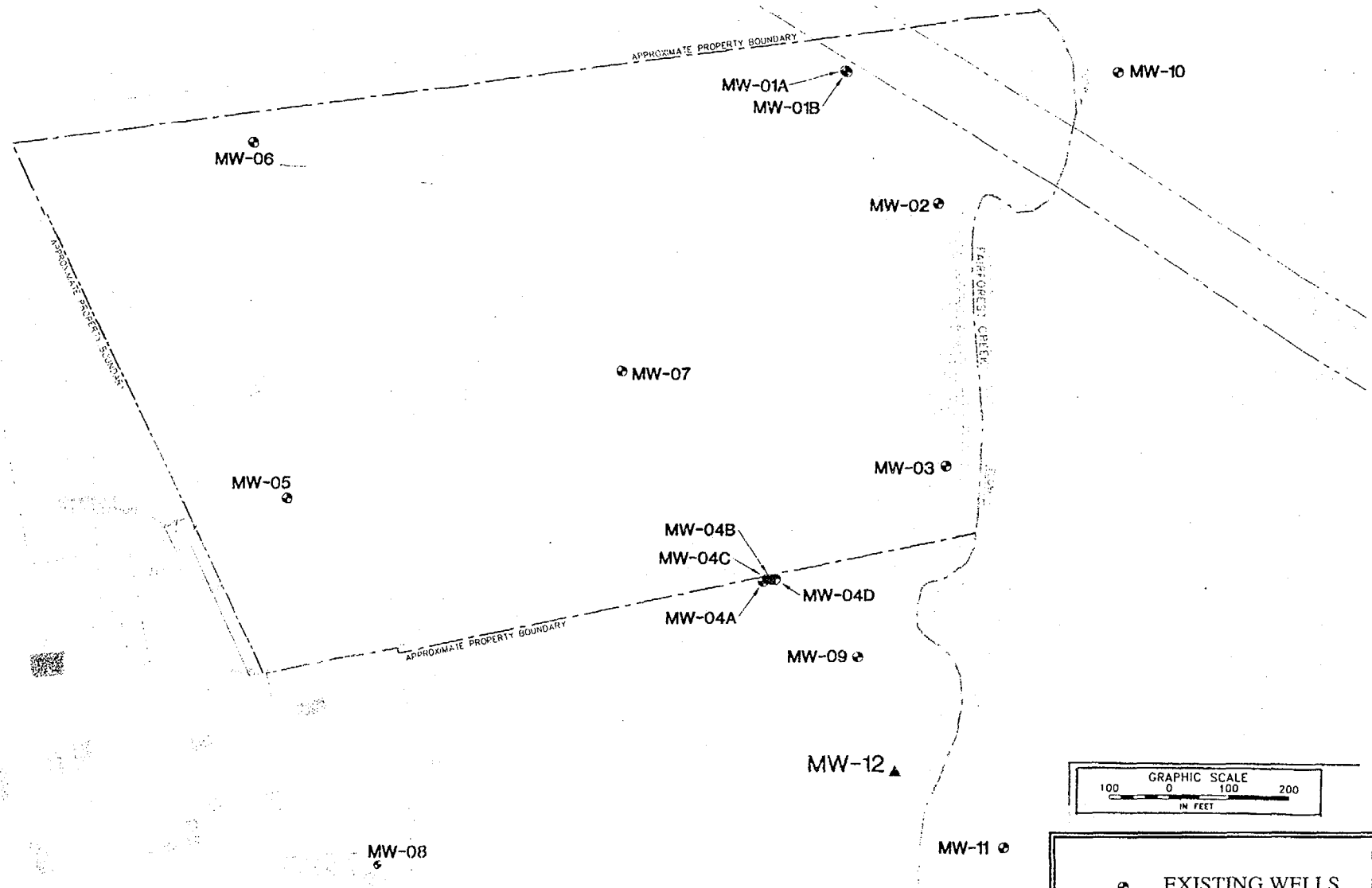


FIGURE I-1. Groundwater Monitoring Program Wells

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**Alternative 2 - Institutional Controls**

- Institutional controls to limit Site use
- Monitoring of groundwater
- Fencing installed around Site perimeter

Estimated Capital Cost: \$200,000

Est. Total O&M (Annual / 30 yrs): \$40,000 / \$470,000

Est. Total Present Worth Cost: \$670,000

Estimated Time to Reach RAOs: N/A

This alternative uses institutional controls and one engineering control (fencing) to limit access to the Site, thereby preventing or limiting exposure to contaminated surface soils on the former landfill. Institutional controls such as signs, easements, covenants, deed notices or deed restrictions, and the regulatory and advisory role the State environmental agency (SCDHEC) fulfills under the water well permitting process, are used to prevent exposure to contaminated groundwater in the future. No actions are taken to intercept migrating groundwater (southeast, northeast) where it has migrated offsite, or prevent its continued release to Fairforest Creek.

Finally, annual groundwater monitoring is included as described above for the No Action Alternative (one annual sampling event). Here and in the following alternatives, a part of the groundwater capital cost (\$100,000) covers installation of one additional monitoring well, in addition to completion of the associated office/field work (permits, oversight, report preparation) necessary to accomplish the monitoring effort.

As with the No Action Alternative, the time needed to reach RAOs cannot be estimated, since RAOs will not be met.

**Alternative 3 - FML Cap and Institutional Controls**

- Institutional controls to limit Site use
- Construction and installation of an Flexible Membrane Liner (FML) cap
- Monitored Natural Attenuation (MNA) of groundwater contamination
- Monitoring of groundwater

Estimated Capital Cost: \$4,670,000

Est. Total O&M (Annual / 30 yrs): \$120,000 / \$1,150,000

Est. Total Present Worth Cost: \$5,820,000

Estimated Time to Reach RAOs: Soil 12-15 months, Groundwater N/A

Alternative 3 adds the construction of a multi-layer FML cap over the landfill area to prevent risks to human health. A Flexible Membrane Liner (FML) cap uses man-made materials such as twin geotextile membranes with a clay liner between them, or sheeting of various plastics (HDPE, LDPE, PVC, etc.) to achieve low permeability, i.e. to limit infiltration of precipitation (rainwater). Compacted soil is used in the base layer of the cap to stabilize the wastes and provide the best

possible foundation for the overlying drainage layer and low-permeability layer(s).

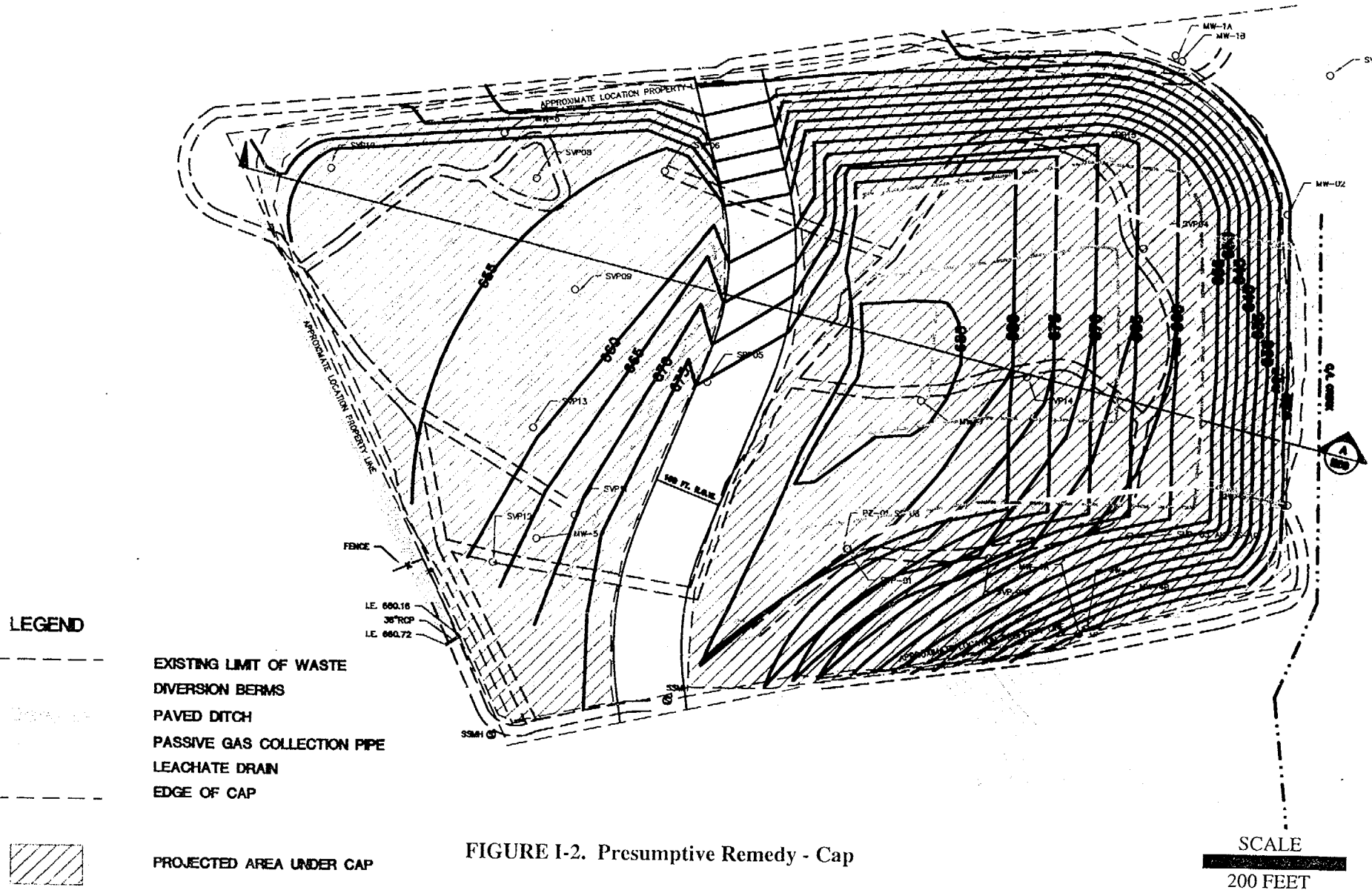
Institutional controls (as described under Alternative 2) are used to prevent exposure to contaminated groundwater in the future. The alternative is "limited action" in the sense that no actions are taken to intercept migrating groundwater or prevent its continued release to Fairforest Creek.

Capping, the Presumptive Remedy, is a containment action in that it physically isolates the wastes, thus blocking potential health risks from the soil exposure pathway. However, capping will achieve some degree of source control on the waste responsible for leaching contamination to groundwater.

In this alternative and all those following, capping includes the following components and assumptions. All areas underlain by wastes will be capped, or the waste will be moved and consolidated as necessary, so that all wastes remaining onsite are capped. The volume of landfilled materials is estimated to be approximately 745,000 cubic yards. In accordance with RCRA Subtitle D and State of South Carolina Solid Waste Landfill regulations, which are relevant and appropriate for this action (see Section M), final grade slopes will achieve a slope of 3:1 for slope stability, unless otherwise approved by EPA and South Carolina during the Remedial Design. The top of the landfill will be graded relatively flat but with sufficient slope to allow water to run off the landfill cover. Nearby soil appears to be available for use as cover material, and RI testing indicates it can be compacted to a permeability of  $1 \times 10^{-5}$  cm/sec. Potential damage to the cover over the waste will preclude construction of a building on all portions of the landfill where the cover is present. Contaminated soil and waste in the small, segregated area on the northeast corner of the property (Figure E-4) will be moved to the main landfill area, and consolidated and covered with the other wastes. A passive landfill gas collection system will be installed under the cap. Current data indicate that landfill gases will not require active treatment.

To construct the cap, waste will be moved and consolidated as necessary to bring the contents to within the boundaries shown on Figure I-2. The final footprint of the capped enclosure will be determined in the Remedial Design. The entire landfill contents will be covered with soil, in lifts, in thicknesses required by the relevant and appropriate State and Federal ARARs. The soil lifts will be compacted to the permeability required by the ARARs (generally, a criterion of  $1 \times 10^{-5}$  cm/sec unless otherwise approved in the Remedial Design). An FML (Flexible Membrane Liner) will be installed over the compacted soil. The FML will be covered with soil layers constructed in accordance with the ARARs, and a vegetative cover (root zone) will be established on the cover. The additional root zone is intended to enhance evapotranspiration. (Note: Alternative 5 does not include the FML cap, but rather a compacted native soil cap. See below.)

The FS demonstrated that for negligible increased costs, a potential future road corridor can be created along the old ridgeline in the western portion of the Site (Figure I-2). To accomplish this, waste can be removed from along a 100-foot-wide corridor. Removal of the waste reduces the total area of the cap by about 1½ acre. The radii of the turns meet the Spartanburg County



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specification for a 45 mile per hour speed limit. While not required by EPA and SCDHEC, this assumption was used in the FS. Unless the Remedial Design determines otherwise, capping will include moving and consolidating the wastes in order to allow the 100-foot cleared, unoccupied road corridor to remain onsite.

The main capital cost is for the cap alone. The remaining small capital cost (\$100,000) covers groundwater monitoring. Groundwater monitoring (twice annually), as described under Alternative 1, is included. Since no measures are employed to intercept groundwater or mitigate its discharge to surface water, RAOs cannot be achieved.

#### Alternative 4 - FML Cap, Institutional Controls and MNA

- Institutional controls to limit Site use
- Construction and installation of an FML cap
- Monitored Natural Attenuation of groundwater contamination
- Monitoring of groundwater

Estimated Capital Cost: \$4,690,000

Est. Total O&M (Annual / 30 yrs): \$120,000 / \$1,390,000

Est. Total Present Worth Cost: \$6,080,000

Estimated Time to Reach RAOs: Soil 12-15 months, Groundwater 30 yrs

In addition to the installation of a FML cap over the landfill area, as described above for Alternative 3, Alternative 4 uses Monitored Natural Attenuation (MNA) to achieve cleanup of contaminated groundwater. Ongoing biological degradation of the contaminants is carefully monitored to ensure that the decrease in contaminant levels is occurring at a steady, predictable rate.

Monitored Natural Attenuation refers to the reliance on natural processes to achieve remediation of groundwater within a time frame that is reasonable compared to other methods. The processes that are at work include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These *in situ* processes include biodegradation; dispersion; dilution; sorption; volatilization; and chemical or biological stabilization, transformation, or destruction of contaminants. EPA has developed an MNA protocol that provides a framework within which the degradation of contaminants is carefully monitored. MNA involves implementing an EPA-approved framework, or protocol, that prescribes in detail the required number and placement of monitoring wells, sampling requirements (additional chemical analyses), and the accepted methods of measuring successful performance. For most sites, the MNA protocol involves more monitoring wells to demonstrate that MNA is, in fact, proceeding successfully. As noted in Section E.2.2, RI data suggest that ongoing biological degradation of the Site groundwater COCs is occurring.

Besides the cap, significant groundwater capital costs (\$120,000) include the addition of 5 new wells, more wells than Alternatives 2 and 3. It is possible more than 5 would be necessary. O&M costs include monitoring, but are less than the other remaining alternatives (Alternatives 5, 5A, 6).

Groundwater monitoring (twice annually), as described under Alternative 1, is included. However, three (3) additional wells (beyond the 16 wells for monitoring as described under Alternative 1) are assumed to be necessary to monitor the attenuation processes. For comparison purposes it is assumed that RAOs can be reached in 30 years, a comparable timeframe to the other alternatives, but this would have to be verified by a Treatability Study as part of the Remedial Design.

#### Alternative 5 - Soil Cap, Institutional Controls and Groundwater Recovery

- Institutional controls to limit Site use
- Construction and installation of a native soil cap
- Construction and operation of a groundwater pump-and-treat system
- Monitoring of groundwater

Estimated Capital Cost: \$3,760,000

Est. Total O&M (Annual / 30 yrs): \$290,000 / \$3,520,000

Est. Total Present Worth Cost: \$7,280,000

Estimated Time to Reach RAOs: Soil 12-15 months, Groundwater 30 yrs

Alternative 5 uses groundwater recovery and treatment to address contaminated groundwater. Groundwater recovery is often called "pump-and-treat" because the informal term describes in brief what is done when using this treatment technology. Contaminated groundwater is captured using a network of specially-constructed wells, and the water is then treated using one or more methods to remove the contaminants. A common treatment method for VOCs is "air stripping," and this type treatment is used in Alternatives 5 and 5A. Treated water is disposed of through discharge to surface water under permit, to a publicly-owned treatment works, into injection wells if permitted, or by other means. As presented in the FS, the most feasible option at present is to discharge treated groundwater to a publicly-owned water treatment facility.

Figure I-3 illustrates a plausible configuration of two pumping-well lines likely to be sufficient to contain the zone of contaminated groundwater migration at the two Site areas where this appears to be occurring. Alternative 5, with the soil cap, assumes a greater well yield (10 gpm) compared to Alternative 5A (7 gpm).

Pump-and-treat methods can be expected to control the offsite movement of contaminated groundwater. Therefore, this alternative includes a compacted-soil cap without a synthetic liner component (plastic or other man-made materials). A soil cap is expected to reduce infiltration by about 25%, while a FML cap may provide a >98% reduction. The rationale for the soil cap is that a large reduction in the amount of rainwater percolating through the waste is not as crucial if the pump-and-treat system properly captures and treats the water anyway.

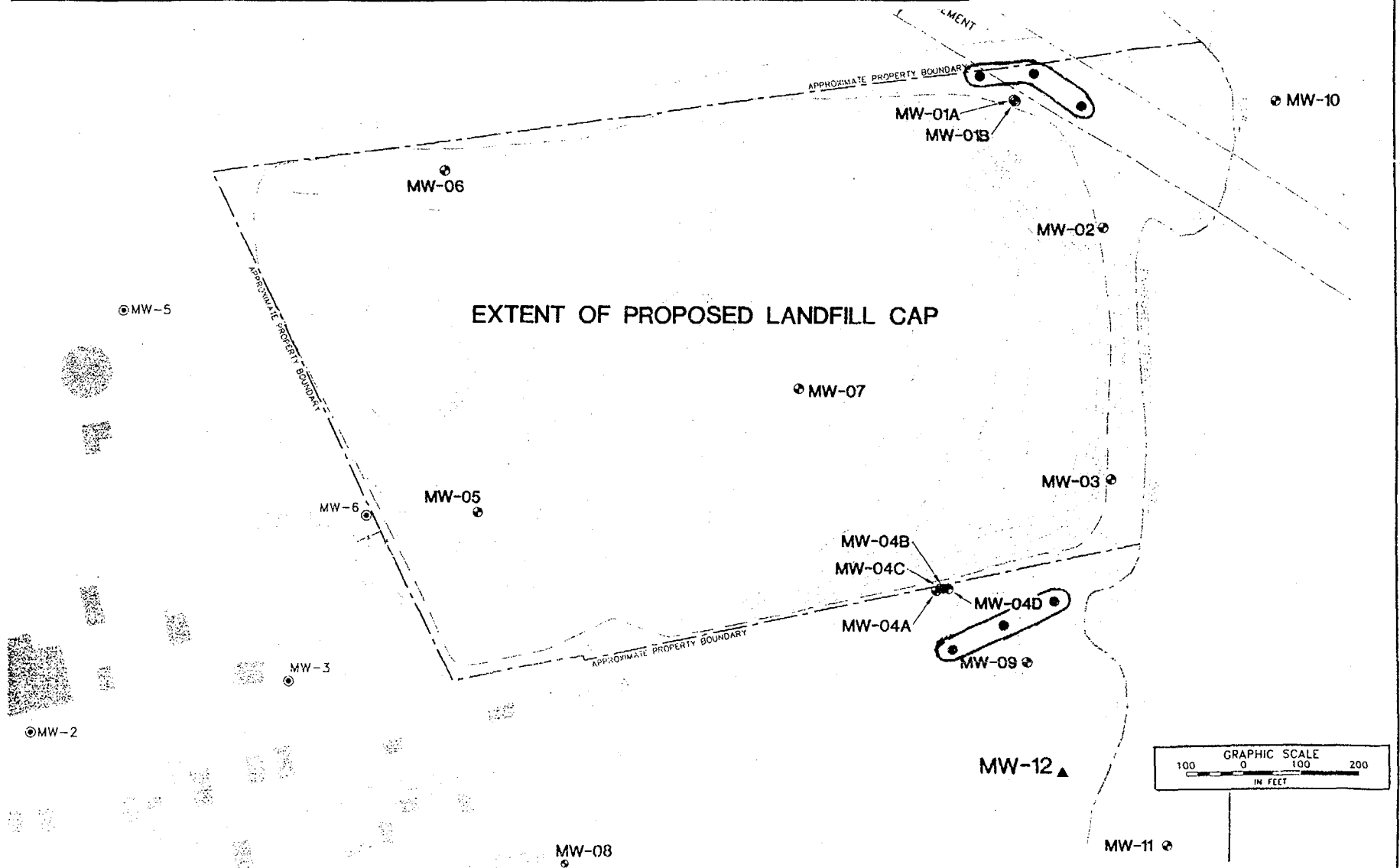


FIGURE I-3. Alternatives 5/5A Groundwater Recovery Systems

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Significant capital costs (\$310,000) beyond the capping cost are required for building the pump-and-treat system. Annual O&M cost for this system are high, making this alternative the most expensive to maintain over the long term. Groundwater monitoring (twice annually), as described under Alternative 1, is included. The estimated time for achieving Site RAOs and performing O&M, may be 30 years or greater.

Alternative 5A - FML Cap, Institutional Controls and Groundwater Recovery

- Institutional controls to limit Site use
- Construction and installation of an FML cap
- Construction and operation of a groundwater pump-and-treat system
- Monitoring of groundwater

Estimated Capital Cost: \$4,880,000

Est. Total O&M (Annual / 30 yrs): \$240,000 / \$2,940,000

Est. Total Present Worth Cost: 7,820,000

Estimated Time to Reach RAOs: Soil 12-15 months, Groundwater 30 yrs

This alternative is identical in all respects to Alternative 5, except that a FML cap is constructed over the waste rather than a compacted-soil cap. The capital costs for the FML cap are higher than the Alternative 5 soil cap by approximately \$1,120,000, or roughly 25%. Similarly high capital costs are expected, and a similar very-high O&M cost is projected. Thirty years or more will be required to reach the RAOs.

Alternative 6 - FML Cap, Institutional Controls and Enhanced Biodegradation

- Institutional controls to limit Site use
- Construction and installation of an FML cap
- Implementation of enhanced biodegradation processes for groundwater
- Monitoring of groundwater

Estimated Capital Cost: \$4,860,000

Est. Total O&M (Annual / 30 yrs): \$100,000 / \$1,170,000

Est. Total Present Worth Cost: \$6,030,000

Estimated Time to Reach RAOs: Soil 12-15 months, Groundwater 30 yrs

Enhanced Biodegradation represents a group of closely-related methodologies for treating contaminated groundwater in-situ, i.e. in place. group of related that enhance microbial degradation of chlorinated organics by providing, to the indigenous microbial populations, a substrate that furthers their degradation of the organic compounds. Substantial reductions in contaminant levels have been achieved at many sites.

There are a number of process options, relating to the particular substrate used; one or more of them could be used. One representative of this group of technologies is Hydrogen Release

Compound, or HRC. HRC is a proprietary, environmentally safe polylactate ester, such as sorbitol polylactate ester, which has been formulated for the slow release of lactic acid upon hydration in groundwater. The lactic acid produces conditions favorable to organisms that carry out anaerobic reductive dechlorination of chlorinated VOCs such as tetrachloroethene and trichloroethene, both of which are present at the Site. HRC is typically injected into the subsurface by pumping the material, which the vendor describes as having the viscosity of honey, using direct push methods or by drilling. The material can be injected into bedrock fractures by pumping into wells drilled into the rock. This bedrock-injection technology has been implemented at a few sites, but is less well demonstrated, however.

Other similar process options for enhanced biodegradation treatment include injection of molasses, and injection of vegetable oil. The basic processes, requirements and limitations are the same.

These bioremediation methods rely heavily on injection of the amendment. A Treatability Study will be necessary at the start of Remedial Design to investigate (1) delivery strategies into the fractured bedrock aquifer, (2) comparative performance of the different options in relation to the geochemistry of the groundwater, and (3) methods for demonstrating effectiveness of the treatment.

The locations for the injection treatments would likely be determined by the Site wells showing the highest contaminant levels, and focused on the source area along the toe of the landfill. To illustrate the general process, the HRC or other treatment solution would be injected into the subsurface downgradient of the landfill in the areas where the concentrations of chlorinated VOCs are highest. The HRC is in a gel form that would be injected using a direct hydraulic push technology, such as GeoProbe®. A column of HRC would be injected from probe refusal, which is presumably the top of bedrock, to the top of the water table. The treatment strategy would be revised and further refined as necessary during the Remedial Design based on Treatability Study work.

Injection into bedrock is likely to be more problematic and would be implemented based upon the results of a pilot-scale treatability study for one or more of the process options. Thus Alternative 6 includes such a treatability study. Its purposes would include evaluating the effectiveness of the process options, investigating delivery strategies for bedrock, and gathering necessary design information. The treatment would be targeted to the areas around the toe of the landfill that were found to be significant sources of contaminants to the groundwater. The areas to be addressed by this alternative are shown in Figure I-4. Treatability study results would be considered in selecting the actual locations where the treatment would be performed.

As with all of the alternatives, there are uncertainties about costs for Alternative 6. For example, the treatment may be implemented only once; or it may be done periodically, with monitoring periods ongoing between treatments, resulting in additional modest O&M costs. Additionally,

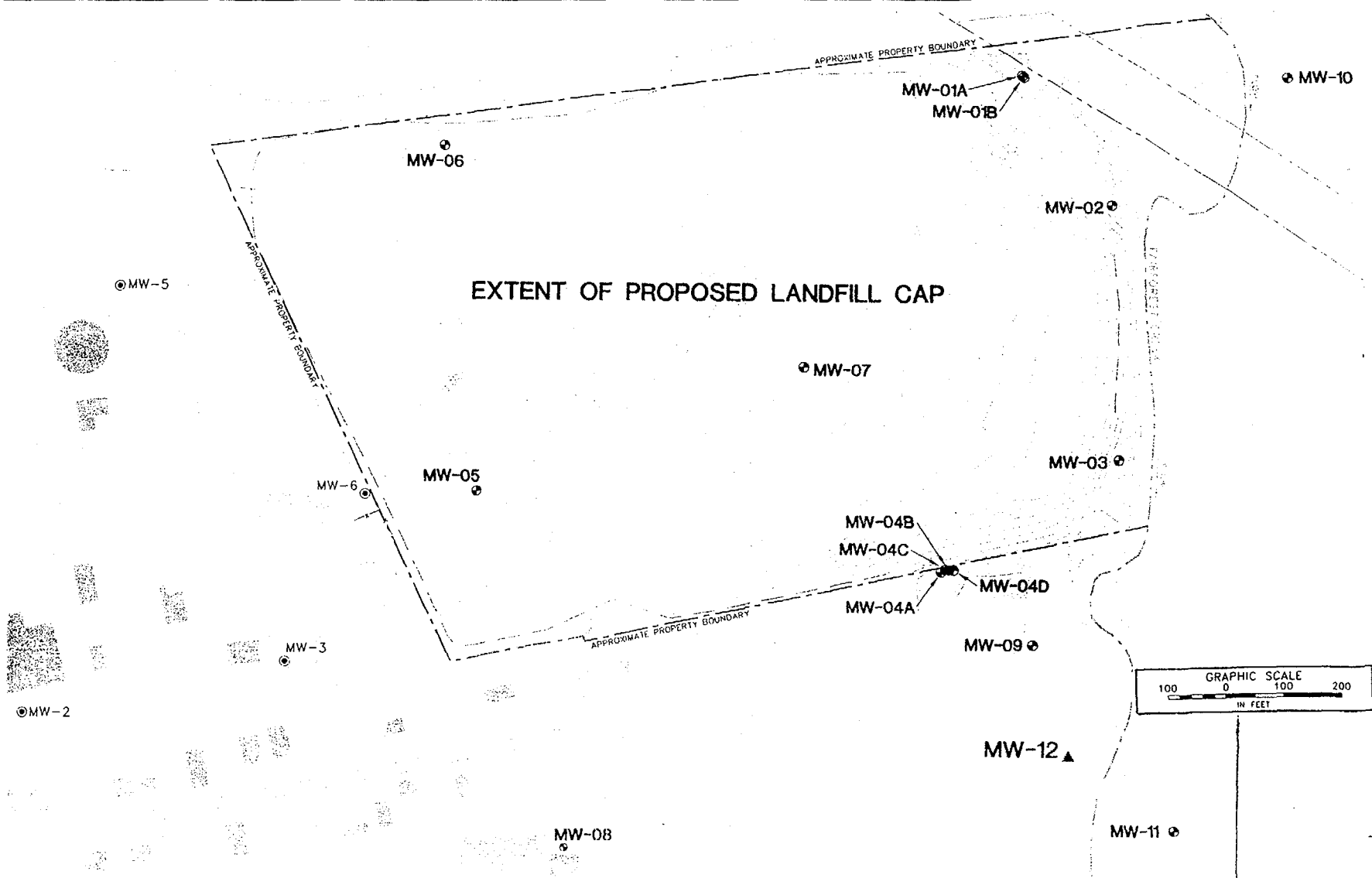


FIGURE I-4. Alternative 6 Enhanced Biodegradation Treatment Areas

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depending on the effectiveness of the treatments, the time required to reach RAOs may be significantly shorter than 30 years. For comparison, however, a 30-year period is assumed. Groundwater monitoring (twice annually), as described under Alternative 1, is included; however, it also includes one additional well beyond those described for monitoring under Alternative 1 above.

## I.2 Common Elements and Distinguishing Features of the Alternatives

This section presents information highlighting similarities and distinctions among the alternatives. These characteristics provide additional basis for the comparative analysis made in Section J. For ease of reference in the following discussion, the titles and components of the seven alternatives are listed here.

Alternative 1 -	No Action
Alternative 2 -	Institutional Controls
Alternative 3 -	FML Cap and Institutional Controls
Alternative 4 -	FML Cap, Institutional Controls and MNA
Alternative 5 -	Soil Cap, Institutional Controls and Groundwater Recovery
Alternative 5A -	FML Cap, Institutional Controls and Groundwater Recovery
Alternative 6 -	FML Cap, Institutional Controls and Enhanced Biodegradation

A number of State and Federal applicable or relevant and appropriate requirements (ARARs) apply to all of the alternatives that include the Presumptive Remedy (capping), i.e., all alternatives besides No Action (Alternative 1) and Institutional Controls (Alternative 2). The main ARARs applicable to capping activities are the RCRA Subtitle D landfill requirements (40 CFR Part 258), and the State of South Carolina Solid Waste Management Regulations for municipal landfills (Reg. 61-107.258). Clean Air Act requirements are not foreseen for the passive venting planned under the capping alternatives, based on Site data. Federal Occupational Health and Safety Administration (OSHA) regulations will govern onsite work during cap construction. Since onsite observations indicate that the landfill has surface runoff and soil erosion going into Fairforest Creek, the capping action plays a part in meeting the intent of meeting the Federal and State Ambient Water Quality Criteria (AWQCs) and the Wetlands Protection Act (Executive Order 11990 and CWA Section 404), under the Clean Water Act, by preventing such erosion.

For the same reasons, the storm water provisions of the National Pollutant Discharge Elimination System (NPDES) are applicable to cap construction. Finally, since the capping action will involve land along Fairforest Creek and could affect the creek itself, Executive Order 11988 (Floodplain Management) and the Fish and Wildlife Coordination Act (40 CFR Section 6, Part 302), respectively, will apply.

Similarly, the major ARARs for the groundwater components of the alternatives apply to all of the alternatives besides No Action (Alternative 1), except for three which concern only the

groundwater recovery alternatives (Alternatives 5 and 5A). The National Primary Drinking Water Standards from the Safe Drinking Water Act, are relevant and appropriate because the aquifer, by State and EPA classification, is a potential drinking water source. As with the cap, Federal Occupational Health and Safety Administration (OSHA) regulations will govern onsite work during onsite activities for the groundwater actions, whether sampling, construction of a recovery system, sampling wells, performing injection treatments, or others.

The ARARs that are different include portions of the Clean Water Act and the Clean Air Act. Clean Air Act requirements could be applicable to the treatment device (air stripper) used in Alternatives 5 and 5A, which produces vapor emissions from treating the water, although the FS concludes this would be unlikely. If the treated water is to be discharged to a surface water body, the wastewater provisions of NPDES (Clean Water Act) are applicable. Finally, those State and Federal regulations governing the transport and disposal of hazardous wastes (Federal Resource Conservation and Recovery Act (RCRA), SC Reg. 61-79) would apply if the treatment process generates hazardous wastes.

One common element among Alternatives 2 through 6 (all except the No Action Alternative) is the use of institutional controls to control Site property use. The need for such controls is foreseen, given that access to the Site is unrestricted, legal decisions about future use have not yet been made, and there are no zoning ordinances in place. According to Spartanburg County, zoning ordinances are not likely to be instituted in the foreseeable future. Specific local controls which may prove necessary could include easements, covenants, deed notices, or deed restrictions. These may require action at the County government level. The state health agency (SCDHEC) has an advisory role to the public concerning installation of potable water wells, and this will also assist in preventing the possibility of exposure. A certain degree of control may be attained if the Site property were purchased by the City, County, or nonprofit entity (covenants or easements). At present, which specific actions are necessary is difficult to foresee. Therefore, implementing institutional controls effectively will require significant planning in the Remedial Design phase, to include an "Institutional Controls Plan" as part of the design. EPA expects to work with the landowner, local authorities, and the community to ensure that Site use remains consistent with the remedy.

Institutional controls may also be necessary in the areas where Site groundwater contamination has migrated offsite. To the southeast, Site contaminants are present at MW-9 and discharge to Fairforest Creek. To the northeast, the VOC detections in groundwater feeding Fairforest Creek (samples MP-80 and MP-96, Table E-3) probably also represent contaminated Site groundwater moving offsite, under the former IMC Fertilizer plant property. Control measures would be intended only to restrict the use of groundwater. The IMC Site has an ongoing RI/FS in progress, and the need for any controls in the near term is unlikely. The "Institutional Controls Plan" noted above will address offsite properties as necessary.

All of the capping alternatives (Alternatives 3 through 6) include an engineering control, fencing installed around the Site perimeter (as noted for Alternative 2). Although included, it is considered optional, to be used if necessary for construction security. The one significant difference among the alternatives that include capping concerns the use of a synthetic liner. Alternative 5 (Presumptive Remedy (Soil Cap), Institutional Controls, and Groundwater Recovery) includes a cap constructed using native soil that is compacted to achieve an appropriate permeability criterion. Based on State Solid Waste Landfill Regulations, the criterion is  $1 \times 10^{-5}$  cm/sec or less. In all other alternatives, a Flexible Membrane Liner (FML) is installed between the soil layers to achieve a superior reduction in permeability.

One common element of those alternatives which include groundwater components (Alternatives 4, 5/5A, and 6) is the focus the treatment on VOCs, rather than the one inorganic Site groundwater COC, manganese. Manganese is believed to be a product of the reducing (oxygen-depleted) environment in and around VOC-bearing water that is being microbially degraded. Biological degradation of the chlorinated organics (Alternatives 4, 6) or their removal (Alternatives 5, 5A) represents the best and perhaps only ways to allow dissolved oxygen levels to rebound enough so that manganese is no longer produced. For this reason, manganese will not require a separate treatment component from those aimed at VOCs.

The time periods for the different alternatives to achieve Site RAOs (Section H-1) have a significant degree of uncertainty associated with them, but this is entirely due to uncertainties regarding the groundwater RAOs. For Alternatives 1 (No Action) and 2 (Institutional Controls), the soil RAOs and groundwater RAOs will not ever be achieved, since soil risks on the landfill will remain and no groundwater action will be taken.

Capping, whether using native soil only (Alternative 5) or the FML liner (Alternatives 3, 4, and 5A), will require approximately 12-15 months to design and construct. Upon cap construction, the RAOs for soil will be met. Thus both Alternative 3, which has the FML cap but uses only institutional controls to address groundwater, and Alternative 4, which has the cap and employs MNA to address groundwater, will meet soil RAOs (only) in 12-15 months from Remedial Design start.

The time period required for achieving groundwater RGs (and hence RAOs) is uncertain and could be decades. The source, in the landfill, cannot practicably be removed, and the eventual scale of the reduction in leachate generation caused by emplacement of the cap is unknown. For this reason, a 30-year monitoring period was assumed to apply to all alternatives. Since meeting Site RAOs requires meeting the groundwater RAOs, the uncertainties described below apply to Alternatives 3, 4, 5, 5A, and 6.

Alternatives 3 and 4 use institutional controls and MNA, respectively, to address groundwater. Neither of these Alternatives involves actively intervening to change the extent, degree, or migration of the existing groundwater contamination. Although the completion of a cap over the

wastes will have some effects on underlying groundwater chemistry, and even though the character of the effects could be positive overall if naturally-occurring biodegradation processes are expanded in the altered groundwater, there is still no basis to predict how much time will be required to reach RAOs for these two alternatives.

Alternatives 4 (using MNA), 5 and 5A (groundwater recovery) and 6 (enhanced biodegradation) will require similar time frames, probably 6 to 9 months, to design the remedial action (5, 5A) or to plan it using treatability studies (4, 6). All four alternatives include the cap, which as noted above, may have positive effects on the Site's groundwater. However, the expected time periods required to achieve RAOs for these four alternatives are difficult to predict and could be very long, even decades. The following three points bear on this similarity.

1. For Alternatives 5 and 5A, which use groundwater recovery (pump-and-treat), the reasons for the expected lengthy time period relate to two factors. First, the contamination is in fractured bedrock, which often limits and controls where and to what degree pumping is effective. Secondly, there are inherent chemical inefficiencies ("performance dropoff" and "rebound" effects) known from experience with other groundwater recovery and treatment systems, that can affect pump-and-treat remediation.
2. For Alternative 4, using MNA, as noted above, there is no basis currently for predicting how much time will be required to reach RAOs. In the FS and this ROD, MNA is given the benefit of the doubt, and an assumed 30-year period is used for comparison.
3. For Alternative 6, the uncertainty about the length of time that will be required relates to the degree of effectiveness achieved by the insitu biological enhancement treatments. If the treatment is effective in any degree, however, then the time period would be shortened in comparison to MNA.

Alternatives 4 (FML cap and MNA) and 6 (FML cap and enhanced biodegradation) are distinct from the other two groundwater recovery alternatives (5, 5A) in their requirement that a groundwater treatability study be performed as part of the Remedial Design. The study would be initiated after the cap is installed, due to the expected chemical changes to the underlying groundwater characteristics that will be caused by cap installation (reduced oxygen content, altered redox characteristics, and other effects resultant from permeability reduction and blockage of infiltration).

As shown in Table I-1, the alternatives have a range of costs. The No Action (Alternative 1) is the least costly, followed by the institutional controls only alternative (Alternative 2). The total costs for Alternatives 3, 4, 5, 5A, and 6, which all include a cap and a groundwater component, range from \$5.82 million to \$7.82 million.

The two groundwater recovery alternatives (5 and 5A) are distinguished by having the highest capital costs, although Alternative 6 (enhanced biodegradation) is within 7%. The Alternative 6 cost estimate includes only the initial application of HRC or treatment solution; if additional treatments proved necessary, each one would add \$100,000. Alternative 2 (institutional controls only) includes a fence around the Site, which doubles its groundwater capital cost compared to Alternative 3 (FML cap and institutional controls), which is identical otherwise with respect to groundwater.

The annual groundwater O&M cost, and the associated net present worth cost, is much higher for each of the two groundwater recovery alternatives in comparison to Alternatives 4 or 6.

Each alternative was evaluated in the FS without a built-in contingency remedy. Should a remedy prove ineffective, EPA believes that the uncertainties about all of the available groundwater components would require that a full review and consequent ROD amendment be completed.

The enhanced biodegradation included as the groundwater component in Alternative 6 should be considered an "innovative technology," in view of the limited number of sites in treatment and limited use in fractured bedrock.

### I.3 Expected Outcome of Each Alternative

Under the No Action alternative, the Site would remain as is. Based on the potential future land use scenario, Site visitors and nearby groundwater well users would continue to have long-term health risks. Groundwater contamination escaping to adjoining properties and Fairforest Creek would continue.

Under Alternative 2, Institutional Controls, the Site would be fenced but otherwise left as is. Long term health risks from soil would remain, given the poor condition (and in many places absence) of the soil cover. Groundwater contamination escaping to adjoining properties and Fairforest Creek would continue.

**TABLE I-1**  
**Remedial Alternatives Cost Summary**

Alternative Title		Cost (Million \$)						
		Total Capital-Capping	Total Capital-Groundwater	Annual O&M Cap	Annual O&M Groundwater	Present Worth O&M Cap	Present Worth O&M Groundwater	TOTAL PRESENT WORTH COST
1	No Action	0	0.07	0	0.04	0	0.47	0.53
2	Institutional Controls	0	0.20	0	0.04	0	0.47	0.66
3	FML Cap and Institutional Controls	4.57	0.10	0.06	0.06	0.68	0.47	5.82
4	FML Cap, Institutional Controls and MNA	4.57	0.12	0.06	0.06	0.68	0.71	6.08
5	Soil Cap, Institutional Controls and Groundwater Recovery	3.45	0.31	0.06	0.23	0.68	2.84	7.28
5A	FML Cap, Institutional Controls and Groundwater Recovery	4.57	0.31	0.06	0.18	0.68	2.26	7.82
6	FML Cap, Institutional Controls and Enhanced Biodegradation	4.57	0.29	0.06	0.04	0.68	0.51	6.05

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Alternatives 3 through 6, which all include a cap, would leave the Site property usable in the manner described in Section F. Site monitor wells will be present but should not interfere with use.

Groundwater use in the nearby area is for non-potable uses. Beneficial use of the aquifer for potable water in the future would be restored under Alternatives 4, 5, 5A, and 6, although the time necessary to achieve cleanup is uncertain.

## **J. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES**

The National Contingency Plan (NCP) requires the analysis of remedial alternatives according to nine overall criteria. Descriptions of these, and a narrative evaluation of the strengths and weaknesses of the alternatives, are presented in this section of the ROD.

The initial evaluation is made according to two threshold evaluation criteria:

1) overall protection of human health and the environment; and 2) compliance with ARARs. An alternative must meet these two criteria to be eligible for selection as the remedy.

Remaining alternatives are then subjected to a comparative analysis based upon five primary balancing criteria: 1) long-term effectiveness and permanence; 2) reduction of toxicity, mobility, and volume through treatment; 3) short-term effectiveness; 4) implementability; and 5) cost. These criteria allow EPA to consider the trade-offs in these aspects of performance, and make judgements about the overall case for, and against, each alternative.

Finally, two modifying criteria are considered: 1) state/support agency acceptance, and 2) community acceptance. These criteria are important and may cause EPA to alter its preferred remedy choice.

In the Feasibility Study, all potential methods and technologies for remediation of groundwater were developed and then screened based upon the general categories of effectiveness, implementability, and cost. Remaining technologies were then eligible for assembling, with the Presumptive Remedy (capping), into remedial alternatives. Similarly, capping options were screened, and those passing screening were assembled in a logical manner with the groundwater actions. Seven (7) remedial alternatives were assembled, which were then analyzed and compared according to the nine NCP criteria.

## J.1 Threshold Criteria

### J.1.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

All of the alternatives except Alternative 1 (No Action) can, if implemented properly, achieve some degree of protection of human health and the environment. The No Action alternative, which does not address potential exposure pathways or contaminated media, is not considered further in this analysis.

Alternatives 2 and 3 rely on institutional controls to eliminate risks from groundwater, but do not include actions to prevent or lessen groundwater discharge to surface water. Thus no additional protection of the environment beyond the current situation is provided. The degree of protection to both human health and the environment is judged inadequate, and these two alternatives are not considered further.

Alternatives 4, 5, 5A and 6 are expected to provide adequate protection of human health and the environment. All four alternatives include a cap to eliminate potential exposure to Site soils and landfill wastes, and minimize leaching to groundwater. Alternatives 5 and 5A use groundwater recovery and treatment systems to reduce groundwater contamination and eliminate risks from groundwater. Alternative 4 employs MNA to reduce groundwater contaminant levels and remove groundwater risks, while Alternative 6 uses enhanced biodegradation to accomplish this.

### J.1.2 Compliance with ARARs

Section 121(d) of CERCLA and NCP § 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs", unless such ARARs are waived under CERCLA Section 121(d)(4).

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those State standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive

requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those State standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate.

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides a basis for invoking a waiver.

Alternatives 4, 5, 5A, and 6 all include a cap, although alternative 5 uses the compacted soil cap rather than the FML liner. Stringent testing would be necessary to show that a soil cap could meet the cover permeability requirement under the ARARs for closure of solid waste landfills; at present there is some doubt as to the certainty of achieving the required permeability. For comparison purposes, however, Alternative 5 will be considered further in the analysis.

Alternatives 4, 5, 5A, and 6 are expected to meet their respective ARARs, although the length of time necessary to meet Site groundwater RGs could be 30 years or more. The main ARARs for the different alternatives are discussed in Section I-2.

Additionally, while Alternative 4 is retained for consideration, it should be noted that both the EPA framework for MNA, and the corresponding State framework under "Mixing Zones" permits, do not typically allow ongoing surface water discharge such that surface water bodies are impacted above ambient water quality standards.

## J.2 Primary Balancing Criteria

### J.2.1 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

The main capping comparison concerns the inclusion or absence of a synthetic (FML) liner. Either type of cap, if properly maintained, can maintain permanent protection from the soil exposure pathway. While a compacted native soil cap is likely equally effective in isolating the wastes, it is greatly less effective at lessening the ongoing leaching of contamination to groundwater. The reduction of infiltration expected from the FML cap makes it superior to the soil cap in terms of long-term effectiveness.

The alternatives which use pump-and-treat methods, Alternatives 5 and 5A, would generally be expected to achieve long-term effectiveness and permanence. However, there could be problems in long-term performance and success, based on EPA and industry experience at many groundwater pump-and-treat sites. Chemical constraints are often present that lead to decreasing effectiveness over time. Monitored Natural Attenuation (Alternative 4) and Enhanced Biodegradation (Alternative 6) both rely on biological degradation of the contaminants, and the reduced contaminant levels both achieve should be permanent and thus long-term effective, once accomplished. However, Alternative 6 has an advantage in that the use of one or more amendments to enhance biological degradation offers the possibility of faster reduction in contaminant levels, as compared to MNA, which is limited to the ongoing, natural baseline rate of biological degradation. The MNA approach also has no means to prevent the continued discharge of groundwater to surface water. For these reasons, and in view of the potential for effectiveness problems with groundwater pump-and-treat systems, Alternative 6 has a clear advantage on this criterion.

#### J.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Alternatives 3, 4, 5A, and 6 include capping with the FML liner, the Presumptive Remedy, which is a containment action. However, the cap will accomplish a significant reduction in the mobility of the VOC waste that is leaching contamination into groundwater from within the landfill. Volume and toxicity of the waste will not be reduced; however, the volume of contaminated groundwater emanating from the landfill will be significantly reduced. The native soil cap included in Alternative 5 will achieve significantly less effect in this regard.

Alternatives 5 and 5A, which use groundwater recovery and treatment (pump-and-treat), will intercept and thus greatly reduce the mobility of the affected groundwater, through hydraulic capture, but lowering toxicity and volume will require that large amounts of groundwater be treated over long periods of time. Pump-and-treat systems also generate large amounts of treated groundwater that must be disposed of.

Alternative 4, using MNA, and Alternative 6, using enhanced biodegradation, both take advantage of biological degradation to reduce the toxicity and volume of contaminated groundwater, although degradation process can be slow and there is no change in groundwater mobility. With Alternative 6, however, the insitu biological treatments will enhance or accelerate the biological processes, which affords the possibility of achieving the Site RGs faster than would be possible with MNA.

### J.2.3 Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup goals are achieved.

The most immediate potential for exposure at the Site, from Site soils, would be alleviated within 12-15 months upon completion of the cap. This applies equally to all remaining alternatives (4, 5, 5A, 6). About the same length of time is required whether or not the cap includes an FML liner.

Any potential short-term health and safety impacts likely to result from Site cleanup originate with the capping actions which are part of all remaining alternatives. Capping operations will involve extensive earth-moving operations, large areas of soil exposed for varying lengths of time, vehicular traffic, and related difficulties. These issues can be safely handled through proper application of occupational health and safety protocols, airborne dust suppression, control of surface water runoff, and similar measures. Coordination and outreach to nearby residents will be essential for minimizing impacts to residents (dust, noise). Short-term groundwater issues associated with the cap are not expected to be significant, and can be addressed through adherence to an approved site health and safety plan.

For groundwater, all of the alternatives involve long time periods to accomplish and verify the cleanup. Thus there is almost no difference in short-term effectiveness due to the relatively long period of time necessary to achieve RGs.

### J.2.4 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Alternatives 5 and 5A, which use groundwater recovery and treatment, are implementable and should pose no particular difficulties beyond those expected for any engineering "construction" remedy where a treatment system, enclosure, building, and/or other structures must be built. Such actions typically have a multi-phase remedial design to design the system and its components.

Both Alternatives 4 (Capping (FML) and MNA) and 6 (Enhanced Biodegradation) are also readily implementable. In the case of Alternative 4, MNA must be done according to a strict protocol that involves extensive meetings and communication, the installation of additional wells (the most among the alternatives) to establish plume flow directions and boundaries, and other difficulties. However, the MNA framework does not accord well administratively with State regulations concerning groundwater and surface water cleanup, which can further complicate implementation. The need for a Treatability Study, and its central role in deciding the manner of applying MNA, are also factors considered.

Alternative 6 (Enhanced Biodegradation) also includes a Treatability Study that is similarly crucial in determining how to apply the in-situ treatments. Actual field implementation may pose some modest difficulties and complications, given limited industry experience with bedrock treatments, but these can most likely be overcome.

Overall, there is no clear distinction on this criterion. The pump and treat alternatives, Alternatives 5 (Capping (Soil) and Groundwater Pump & Treat) and 5A (Capping (FML) and Groundwater Pump & Treat) are more "off the shelf" and routine to implement, and thus easier to implement, although they do represent multi-phase large-scale engineering projects. The remaining Alternatives, 4 (Capping (FML) and MNA) and 6 (Capping (FML) and Enhanced Biodegradation) are readily implementable from a field/technical perspective, but both involve Treatability Studies and some administrative difficulties.

#### J.2.5 Cost

The final balancing criteria considered is cost. By comparing what each alternative is expected to accomplish, and its cost, to the other alternatives, the cost-effectiveness offered by each alternative can be considered.

As shown in Table I-2, Alternatives 5 and 5A have the highest costs. In terms of cost-effectiveness, EPA believes that no additional effectiveness is obtained for the \$1.2- to \$1.7-million cost differential between the two pump-and-treat alternatives, and the cost range of Alternatives 4 (Capping (FML) and MNA) and 6 (Capping (FML) and Enhanced Biodegradation). As noted above there could also be long-term effectiveness issues. For similar cost, Alternative 6 (Capping (FML) and Enhanced Biodegradation) offers the potential to achieve essentially the same cleanup, possibly in less time.

### J.3 Modifying Criteria

#### J.3.1 State/Support Agency Acceptance

SCDHEC has reviewed the Selected Remedy and concurs with EPA's Preferred Alternative. South Carolina's letter of concurrence on this Record of Decision is attached at Appendix C.

#### J.3.2 Community Acceptance

At the public meeting held during the public comment period, community members had a number of general questions concerning the RI and the timing and scope of the proposed remedy. No specific preferences for any particular alternative were expressed. Two (2) sets of written comments were received, and one of those included specific concerns about the proposed remedy, although not disagreement with its selection (Appendix A). One citizen had a health-related question about RI findings. In general, the community is supportive of the selected remedy and is ready to see cleanup actions proceed as soon as possible.

## K, PRINCIPAL THREAT WASTES

The NCP establishes an expectation that EPA will use treatment to address principal threats posed by a site wherever practicable. The 'principal threat' concept is applied to the characterization of 'source materials' at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water or air, or acts as a source for direct exposure. Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are defined as those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal threat wastes are those source materials that generally can be reliably contained and that would present only low risk in the event of exposure.

According to *A Guide to Principal Threat and Low Level Threat Wastes (OSWER 9380.3-06FS, November 1991)*, wastes that generally do not constitute principal threats include, but are not limited to, the following: (1) non-mobile contaminated source material of low to moderate toxicity ( surface soil containing chemicals of concern (COCs) that generally are relatively immobile in air or groundwater, i.e., non-liquid, low-volatility, low-teachability contaminants such as high molecular weight compounds ) and (2) low toxicity source material (soil and subsurface soil concentrations not greatly above reference dose levels or that present an excess cancer risk near the acceptable risk range were exposure to occur).

At this site, a determination of whether principal threat wastes exist in the landfill cannot be made, since minimal information is available on the physical and chemical characteristics of the waste. During the RI, extensive soil sampling and examination of landfill contents in test pits did not identify any "hot spots" or concentrated wastes. Samples from the other contaminated media (primarily groundwater) do not display the high concentrations and high toxicity levels that are characteristics of principal threat wastes.

## **L. THE SELECTED REMEDY**

Based upon consideration of the requirements of CERCLA, the detailed analysis of the alternatives proposed in the feasibility study using the nine (9) criteria, and public comments, EPA

has chosen Alternative 6, FML Cap, Institutional Controls and Enhanced Biodegradation as the Selected Remedy for this Site.

The following sections provide the rationale and basis for selecting Alternative 6, an expanded remedy description, a summary of the expected costs, and a description of the expected outcome of implementing the remedy.

### **L.1 Rationale for the Selected Remedy**

As discussed in the comparative analysis (Section J), capping of the Site using an FML liner, rather than compacted soil, achieves superior long-term effectiveness and significantly lowers the mobility of contamination leaching to groundwater, in addition to physically isolating the wastes and blocking exposure to Site soils. Among the groundwater components, the use of enhanced biodegradation achieves remediation of the groundwater COCs at the same or only slightly greater cost than Monitored Natural Attenuation (MNA). Because biological degradation processes are enhanced or accelerated, Alternative 6 also has the potential to accomplish treatment in less time than MNA. Alternative 6 accomplishes the treatment of impacted groundwater insitu, without the high capital costs and very-high O&M costs associated with groundwater pump-and-treat technology (Alternatives 5, 5A). This comparison holds even if repeat treatments of the biodegradation agent proved necessary. Alternative 6 is also superior to Alternatives 5 and 5A in view of concerns about long-term effectiveness of groundwater pump-and-treat technology.

### **L.2 Description of the Remedy**

A general description of the Selected Remedy is presented in this section. The details of the remedial action, other than those given below, will be set forth and approved by EPA in the Final Remedial Design during the Remedial Design/Remedial Action (RD/RA) phases of the Site response.

The major components of the Selected Remedy (Alternative 6) are:

- Construction and installation of an FML cap
- Implementation of enhanced biodegradation processes for groundwater
- Institutional controls to limit Site use
- Monitoring of groundwater

The Presumptive Remedy component consists of the construction of an FML cap in accordance with the ARARs for solid waste landfills, and the long-term O&M of the cap. To construct the cap, waste will be moved and consolidated as necessary to bring the contents to within the boundaries shown on Figure I-1. The final footprint of the capped enclosure will be determined in the Remedial Design. The entire landfill contents will be covered with soil, in lifts, in thicknesses required by the relevant and appropriate State and Federal ARARs. The soil lifts will be compacted to the permeability required by the ARARs (generally, a criterion of  $1 \times 10^{-5}$  cm/sec unless otherwise approved in the Remedial Design). An FML will be installed over the compacted soil. The FML will be covered with soil layers constructed in accordance with the ARARs, and a vegetative cover (root zone) will be established on the cover. Unless determined otherwise during the design, the remedy will include moving and consolidating wastes as needed to allow a 100-foot cleared, unoccupied road corridor to remain onsite, as shown in the FS. The potential road corridor will not be capped. Fencing around the Site perimeter may be employed, if confirmed in the Remedial Design to be necessary for construction security. Additional requirements will be specified in the Remedial Design.

The groundwater component of the Selected Remedy consists of using Enhanced Biodegradation. This term refers to a group of related methodologies that enhance microbial degradation of chlorinated organics by providing, to the indigenous microbial populations, a substrate that furthers their degradation of the organic compounds. There are a number of process options, relating to the particular substrate used, and because of their similarities, one or more of them could be used. Known process options include injection of molasses, and injection of vegetable oil. Others which may be suitable for use will be identified in the Treatability Study (see below).

A pilot-scale Treatability Study will be conducted during the Remedial Design. At a minimum, the purposes of the Treatability Study will include: a) identification and comparison of possible delivery strategies and methodologies for addressing delivery into the fractured bedrock system; b) identification and comparison of possible treatment solutions/reagents; c) and gathering of other appropriate design information. The Treatability Study may be initiated before cap construction and installation is complete; however, the pilot-scale testing that is expected to be a crucial component cannot be performed until the effects of the cap on underlying groundwater are known, so that the evaluation is focused on the groundwater conditions that exist under the cap at that time and afterwards.

Unless a different strategy is approved in the Remedial Design, the treatment will be targeted on those areas around the northeast toe, and southeast toe, of the landfill that were found in the RI to be significant sources of contaminants to the groundwater (Figure I-4). However, Treatability study results will be considered in selecting the actual locations where the treatment is to be performed.

An example of this group of technologies is Hydrogen Release Compound, or HRC. HRC is a proprietary, environmentally safe polylactate ester, such as sorbitol polylactate ester, which has

been formulated for the slow release of lactic acid and a low-level supply of hydrogen upon contact with water. Lactic acid occurs naturally in milk and foods. HRC enhances natural attenuation in two ways. First, HRC provides a substrate for microbes to assimilate oxygen (to promote anaerobic conditions within the aquifer) or to assimilate nitrate and sulfate, which compete with chlorinated volatile organic compounds such as PCE in anaerobic biological reactions. Secondly, HRC provides a hydrogen source, or electron donor, which can be used by microbes which participate in reductive de-chlorination of chlorinated VOCs, or electron acceptors. One feature of HRC in contrast to other substrates that use other electron donors, such as sugar and molasses, is that it is designed to release hydrogen over a longer time period, requiring less frequent re-application.

In general, the process that will be used consists of injection into the subsurface, in the areas downgradient of the landfill where the concentrations of chlorinated VOCs are highest. Using HRC as an example, HRC is prepared into a gel form that would be injected using a direct hydraulic push technology, such as GeoProbe®. A column of HRC would be injected from probe refusal, which is presumably the top of bedrock, to the top of the water table. For bedrock, the material will be injected into bedrock fractures by pumping into wells, although the specifics of this will be based upon the results of the Treatability Study.

EPA and SCDHEC expect that, with refinement of the treatment process during pilot testing, enhanced biodegradation will be effective in reducing COC levels in Site and offsite-migrating groundwater. As noted, RI data show that the microbial breakdown products of PCE are widespread in Site groundwater; the planned treatments enhance this ongoing degradation and thus accelerates the destruction of the COCs.

It is possible that the enhanced biodegradation treatment may require re-applications, depending on the effectiveness demonstrated in testing. In the event that three (3) treatments do not prove effective, EPA and SCDHEC will review the remedy's effectiveness and will consider modifying or changing the Site Selected Remedy in accordance with the NCP and EPA guidance (e.g. an Explanation of Significant Differences or ROD Amendment, as appropriate).

The Selected Remedy employs Institutional Controls to supplement the active remedial measures by preventing exposure to contaminants in the surface and subsurface soils and underlying landfill materials, and preventing consumption of groundwater beneath the Site and nearby affected adjoining properties during the period of active treatment. Land use decisions by the local community and authorities are likely to take some time to work out, as the ongoing "Regenes Project" proceeds, making it inappropriate to specify, at present, which controls are best for the situation. An Institutional Controls Plan will be required (and approved by EPA) as part of the Remedial Design, to specify the controls needed for both the Site property and nearby affected adjoining properties.

Institutional controls will be necessary for the Site, since physical access to the Site is

unrestricted, and since the cap will require more than one year to install. The purpose of any controls used for the Site property, which could include easements or covenants, or possibly deed notices, will be to prevent exposure to Site soils. Similarly, institutional controls may also be necessary on adjoining properties underlain by offsite-migrating COCs. To the southeast, Site contaminants are present in the area of MW-9; to the northeast, contaminated Site groundwater appears to be migrating offsite under the former IMC Fertilizer plant property and discharging to the creek. Control measures would be intended only to restrict the use of groundwater. The IMC Site has an ongoing RI/FS in progress, and the need for any controls in the near term is unlikely. The "Institutional Controls Plan" noted above will address offsite properties as necessary. EPA expects to work with the landowner, local authorities, and the community to ensure that Site use remains consistent with the remedy.

Finally, groundwater monitoring for Site COCs (Table H-1) will be performed during the entire duration of the Remedial Design and Remedial Action phases. The wells shown in Figure I-2 will be used, along with other wells that may be installed during these phases of work. A semiannual (twice annually) sampling schedule will be maintained initially, unless a different scheme is approved by EPA during design.

### L.3 Summary of the Estimated Remedy Costs

Appendix D provides a detailed breakdown of the anticipated remedy costs. The capital costs are \$4,565,000 for the cap and \$288,000 for groundwater. Present worth cost for 30 years of annual O&M total \$675,000 for cap maintenance and \$516,000 for groundwater O&M. The grand total for the Selected Remedy is \$6.05 million. Although the costs shown appear detailed, it should be noted that they were prepared without benefit of detailed, remedial design and engineering information and (in accordance with guidance) are only expected to be accurate to within +50 to -30 percent of the eventual, actual project cost.

### L.4 Expected Outcome of the Selected Remedy

The Selected Remedy will, upon completion of cap construction, leave the property usable for the types of recreational use described generally in Section F. The cap isolates the wastes and blocks both current and future exposure pathways (dermal contact, ingestion inhalation) for Site visitors. The land usage foreseen is limited only to the degree that it must not interfere with proper maintenance of cap integrity. This would preclude any uses that include construction of buildings. Maintenance of the cap is required to maintain the risk reduction. Cap construction (including design) will require an estimated 12 to 15 months.

Groundwater use on the Site and the adjoining (north, southeast) properties will be impaired during the time period over which the groundwater remedy component is implemented. The length of time required is very difficult to predict, and could be more than 30 years. Upon attainment of the Site RGs (Table H-1), the groundwater beyond the treatment points (beyond the cap edge) will be returned to potential beneficial use as a potable water source.

Implementing the Selected Remedy is expected to provide a boost to ongoing community revitalization efforts, by addressing environmental and health-risk concerns about the Site, and through making the Site available for uses that accord well with the community's vision for their area. Environmental benefits may also be gained to the degree that recreational use of the Site, particularly if it includes a planned "Greenway" along Fairforest Creek, brings additional local attention to the areas of trash and debris present along both sides of the creek north and south of the Site. These areas are scheduled to be surveyed and investigated under the area-wide Brownfields project currently in progress.

## M. STATUTORY DETERMINATIONS

Under CERCLA §121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (ARARs) (unless a statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against offsite disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

### M.1 Protection of Human Health and the Environment

The Selected Remedy, Alternative 6, provides adequate protection of human health and the environment by implementing the remedy components: design and installation of a Flexible Membrane Liner (FML) cap, design and implementation of enhanced biological degradation treatments, using appropriate institutional controls, and conducting groundwater monitoring.

Capping will eliminate the potential for exposure to Site soils and landfill wastes. The cap will reduce the current levels of carcinogenic risk through soil exposure ( $1.57 \times 10^{-6}$ ) to below  $1 \times 10^{-6}$ . Additionally, the cap achieves a measure of source control by minimizing leaching of Site COCs to groundwater.

Groundwater treatment using enhanced biodegradation will reduce or eliminate concentrations of Site COCs above the RGs, and is expected to achieve the Site RGs. Remaining carcinogenic and noncarcinogenic risks will be below those shown in Table H-1.

The implementation of the Selected Remedy will not pose unacceptable or unreasonable short-term risks, or significant cross-media impacts. The potential exposures which drive the most immediate human health risks at the Site are addressed in the short term by capping. Potential exposure under the future use scenario, through groundwater use, will be addressed over the expected longer period of groundwater remediation.

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## M.2 Compliance with ARARs

The Selected Remedy, Alternative 6, complies with ARARs. The ARARs that will govern the Selected Remedy are discussed below.

Action-specific ARARs that govern the capping activities are the RCRA Subtitle D landfill requirements (40 CFR Part 258), and the State of South Carolina Solid Waste Management Regulations for municipal landfills (Reg. 61-107.258), which are judged relevant and appropriate. Federal Occupational Health and Safety Administration (OSHA) regulations regarding work on hazardous waste sites (29 CFR Part 1910.120) are applicable to the onsite work during cap construction.

Certain chemical-specific ARARs are relevant and appropriate to capping. Since the landfill has soil erosion and surface water runoff going into Fairforest Creek, the action plays a part in complying with the Federal and State Ambient Water Quality Criteria (AWQC) regulations established under the Clean Water Act (40 CFR Part 131, SC Reg. 61-69). For the same reasons, the storm water provisions of the National Pollutant Discharge Elimination System (NPDES) are applicable to cap construction. Regarding landfill gas, for which a passive venting system is included in the Selected Remedy, Clean Air Act requirements are not foreseen for the passive venting planned under the capping alternatives, based on Site data. If emissions are later determined to require treatment, Federal and State regulations (e.g. SC Air Pollution Control Regulations, Reg. 61-61) that implement the Clean Air Act (40 USC § 1857) would become relevant and appropriate for use.

Three location-specific ARARs are applicable to capping because the capping action will involve land along Fairforest Creek, some of it wetlands, and since the action could alter or affect the creek itself. These three are:

- Executive Order 11988 (Floodplain Management; 40 CFR Section 6, Appendix A)
- Fish and Wildlife Coordination Act (40 CFR Section 6, Part 302)
- Wetlands Protection Act (Executive Order 11990 and Clean Water Act Section 404)

Chemical-specific ARARs relevant and appropriate to the groundwater remedy component are the State and Federal regulations established pursuant to the Safe Drinking Water Act. The National Primary Drinking Water Standards (40 CFR Part 141) established the MCLs for constituents in drinking water to include groundwater aquifers used as potable water sources. The corresponding South Carolina regulation is SC Reg. 61-58. These regulations sets MCLs for six (6) of the 24 COCs in groundwater at the Site: tetrachloroethene (PCE), trichloroethene (TCE), 1,1-Dichloroethene, cis-1,2-Dichloroethene, benzene, and vinyl chloride. MCLs are specifically identified in the NCP as remedial action objectives for groundwater that is a current or potential source of drinking water (NCP 40 CFR § 300.430(a)(1)(ii)(F)).

Two action-specific ARARs are applicable to the groundwater action. The Federal Occupational Health and Safety Administration (OSHA) regulations concerning work on hazardous waste sites (29 CFR Part 1910.120) are applicable to onsite work during activities such as groundwater sampling, surface water sampling, construction of wellpoints for injections, performing the injection treatments, or others. Finally, the South Carolina regulation for monitor well installations procedures and standards, SC Reg. 61-71, is applicable to all wells used in the Selected Remedy.

### M.3 Other Criteria, Advisories, or Guidance To-Be-Considered (TBCs)

In implementing the Selected Remedy, USEPA may choose to follow criteria, advisories or guidance which would be non-binding. No TBCs were identified in the FS.

### M.4. Cost-Effectiveness

In EPA's judgement, the Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (40 CFR 300.430(f)(1)(ii)(D)). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (Alternatives 4, 5, 5A, and 6). Overall effectiveness was evaluated by assessing three (3) of the five (5) balancing criteria in combination: long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness. Overall effectiveness was then compared to costs to determine cost-effectiveness, for each alternative, and for the alternatives in comparison to one another. The overall effectiveness of this remedial alternative was judged to be proportional to its costs, and therefore it represents a reasonable value for the money to be spent.

Among the remedial alternatives which meet the threshold criteria (Alternatives 4, 5, 5A, and 6), Alternative 6 achieves biological degradation of the groundwater COCs at the same or only slightly greater cost than Monitored Natural Attenuation (MNA, Alternative 4). Significantly, it has the potential to accomplish treatment in less time than MNA. Alternative 6 accomplishes the treatment of impacted groundwater insitu, at much lower capital costs and long-term O&M costs than Alternatives 5 and 5A, which use groundwater pump-and-treat technology. This comparison holds even if repeat treatments proved necessary. For these reasons, Alternative 6 is the most cost-effective of the available choices.

### M.5 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

EPA has determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the Site. Among the remedial alternatives which meet the threshold criteria (Alternatives 4, 5, 5A, and 6),

EPA has determined that the Selected Remedy provides the best balance of trade-offs in terms of the five primary balancing criteria, while also considering the statutory preference for treatment as a principal element and bias against off-Site treatment and disposal, and considering State and community acceptance.

The Presumptive Remedy, capping, is a long-term containment action which isolates the source materials at the Site (within the landfill) and provides some degree of source control against groundwater leaching. Under the Presumptive Remedy approach, neither source removal nor source treatment is practicable.

The groundwater component uses implementation of enhanced biological degradation treatments, an innovative and emerging treatment technology, to treat contaminated groundwater insitu, and permanently destroys or degrades the contaminants through biological action. This represents a permanent treatment that best satisfies the criteria for long-term effectiveness in comparison with other alternatives which use pump-and-treat technology, which often have problems regarding long-term performance.

Institutional controls will be used as needed to control land and groundwater uses during the period of active treatment at the Site.

#### M.6 Preference for Treatment as a Principal Element

As described above, direct treatment or removal of the source materials (principal threat wastes) in the landfill which are leaching to groundwater, is not feasible. Therefore, under the Presumptive Remedy, the preference for treatment of principal threat wastes as a main remedy component, cannot reasonably be met.

The groundwater component of the Selected Remedy achieves in some degree the intent of the preference for treatment. The enhanced biodegradation treatments do not generate additional waste materials that could require disposal, or transfer the contaminants to those media (spent carbon, vapor emissions) as would have been the case had Alternative 5 or 5A (which use groundwater pump-and-treat) been selected.

#### M.7 Five-Year Review Requirements

Section 121(c) of CERCLA, as amended, and the NCP provide the statutory and legal bases for conducting five-year reviews. If there are any hazardous substances, pollutants, or contaminants remaining at the Site above levels that would allow unlimited use and unrestricted exposure, EPA must conduct a review of such remedial action no less often than each five (5) years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In general, a five-year review covers all operable units at a Site.

The Five-Year Review requirements at the Arkwright Dump Site are controlled by the Presumptive Remedy for the Site, capping. EPA 5-Year Review Guidance states that a statutory Five-Year Review will be conducted at any CERCLA site at which remedy completion will not allow unlimited use and unrestricted exposure. A landfill is an example of such a site. Completion of the capping remedy component will eliminate risks from soils and landfill materials, but will not allow unrestricted use; use of the Site will always be restricted to the degree necessary to maintain the cap and assure its effectiveness and integrity. Therefore, a statutory Five-Year Review will be conducted at the Site every five years, in perpetuity, in accordance with the NCP.

#### **N. DOCUMENTATION OF SIGNIFICANT CHANGES**

Four changes are reflected in this Record of Decision that differ slightly from the information presented to the public in the Proposed Plan.

The first concerns the costs shown in this ROD for Alternative 6, which was selected as the remedy. After the FS was approved, it was discovered that the groundwater monitoring analytical costs (item 7.10, costs for Alternative 6, in Appendix C of the FS) should have included 40 VOC samples rather than 34, to allow for six samples representing the two "impacted surface water segments" referred to in the Proposed Plan. This additional cost adds \$1800 to the annual O&M cost and \$22,000 to the overall remedy total; however the same amount would have been added to any of the four alternatives (4, 5, 5A, 6) that included a groundwater component, if selected. Therefore it has no significance in the comparisons made in the comparative analysis (Section J).

Under the Remedial Objectives for the Site, it was implied (RAO No. 2 under "Groundwater") by the language that groundwater under the cap would be restored to potential use as a potable water source. The RAO on page 38 of this ROD, to be used in the Selected Remedy, clarifies that restoration of the aquifer is the RAO for all contaminated groundwater that is not under the cap, once constructed.

Third, the non-carcinogenic and carcinogenic risk totals presented in the Proposed Plan are slightly different from those presented here, which are based on the finalized, approved Baseline Risk Assessment. The changes do not affect the characterization of Site risks as presented to the public, nor do they affect the risk basis for requiring action at the Site. These differences are summarized below.

Risk Element	Proposed Plan, July 2002	Record of Decision
Carcinogenic Risk - Current Site Visitor (child age 7-12) (Lifetime)	$1.5 \times 10^{-5}$	$1.57 \times 10^{-5}$
Carcinogenic Risk - Future Site Visitor (child age 7-12) (Lifetime)	$1.5 \times 10^{-5}$	$1.57 \times 10^{-5}$
Noncarcinogenic Risk - Future Offsite Resident: Child age 1-6 Child (age 7-12) Adult	201 111 78	360 222 142
Carcinogenic Risk - Future Offsite Resident - Adult (Lifetime)	$1.2 \times 10^{-2}$	$7.25 \times 10^{-3}$

Finally, in the Proposed Plan, the RG for manganese ( $880 \mu\text{g/L}$ ) was shown to be based on the Region 9 PRG, and the RG for naphthalene ( $25 \mu\text{g/L}$ ) was shown as based on the South Carolina risk-based standard for UST releases. Calculations in the Final of the Baseline Risk Assessment provide a better Site-specific RG in both cases, and those are the values shown in Table H-1, Remedial Goals.

**APPENDIX A**  
**RESPONSIVENESS SUMMARY**

**RESPONSIVENESS SUMMARY**  
**RECORD OF DECISION, ARKWRIGHT DUMP SITE, SPARTANBURG SC**  
**September 2002**

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**Introduction**

The Responsiveness Summary is required by the Superfund law (CERCLA) and the NCP, to provide a summary of citizen comments and concerns about the Site, as raised during the Public Comment Period, and a description of the Agency's responses to those concerns (CERCLA §117 and NCP §§300.430(f)(3)(i)(F) and 300.430(f)(5)(iii)(B)). All comments summarized in this document have been considered in the development of the Selected Remedy for the Arkwright Dump Site.

The following issues and concerns were expressed during the public comment period by the local community, and by a contractor for the RI/FS project at the adjoining former IMC Fertilizer plant site. The comments are transcribed here in their entirety. Although not included here, the actual comment letters received during the public comment period, and a transcript of the public meeting, are a part of the Administrative Record for this Site.

**PART 1: Local Community Comments and EPA Responses:**

**Comment No. 1:** Community Baptist Church has its eyes on building a new Church. We are located directly across from the dump (the host site for this meeting) in Arkwright. Is the contamination of the soil and gas emissions both ground and airborne such that we should not rebuild in the same location? If the soil on which the Church is located has been tested what were the results?

**RESPONSE:** The results from the soil and soil vapor samples collected at the church are not significant in terms of any potential health risks. There is no reason, in EPA's judgement, why the church could not re-build on the same location.

Results from soil and soil vapor samples are shown in Tables 2.3, 2.4, 2.5, 2.6, and 2.18 of the Feasibility Study (samples labeled "SS-BKG" and "SVP-BKG"). In surface soil, five organic compounds were detected. All of the levels detected are far below any health-based risk benchmarks. Three of the five are gasoline components and probably relate to accidental spillage of gasoline. Deeper soil (40-42 feet below the ground) was sampled and had four organic compounds present; these also were all far below any levels that would cause concern.

The soil vapor sample was collected from a vapor well screened from 30 to 40 feet below ground surface. Six organic compounds were detected. The levels of four of these are above those recommended for ambient air; however, they were detected in a vapor sample from 30-40 feet below ground. The sample does not mean that vapor containing these levels is coming up and entering the air near the church; but even if this is the case, it is highly unlikely that it would pose

a problem for siting a new church. Modern construction methods include vapor barriers, which would prevent problems from vapors. If the landfill is the source of the compounds detected, the passive landfill gas venting system that is part of the Selected Remedy (the cleanup plan), and the effect of the cap itself, should greatly reduce the amount of landfill gas (including vapors) escaping from the Site.

## **Part II: Technical Comments from Contractor on the Former IMC Fertilizer Site**

The first five (5) comments concerned the Feasibility Study Report and the Proposed Plan.

**Comment No. 1:** One of the four Remedial Action Objectives identified in the Feasibility Study Report (Executive Summary, page ES-1 and Section 3, page 3-1) for the Arkwright Dump Site is to "reduce or eliminate the migration of groundwater off site containing contaminants over regulatory levels." The array of alternatives is limited in that only two active remediation technologies: HRC injection for enhanced bioremediation, and migration control using groundwater recovery and treatment, are carried forward as viable technologies to address migration control. A number of technologies are discarded in the screening phase (Section 4) due to limited effectiveness of potential implementation concerns under fractured bedrock conditions. In point of fact, the challenging geologic conditions are also likely to equally impact the effectiveness/implementation of the two retained technologies. There thus appears to be no consistent basis for discarding alternative treatment technologies in the screening phase.

**RESPONSE:** EPA would like to clarify the bases for screening out certain treatment technologies, which may have been misunderstood.

In situ treatment of a source area, and techniques that might use physical barriers such as Permeable Reactive Barriers (PRBs) or reactive walls, were not retained because the locations of sources inside the landfill are not known, and because the depth of contamination will likely interfere with proper installation of such barriers. Several anaerobic treatment options were retained even though implementation may be challenging or difficult. Other anaerobic processes that involve injection of a pollutant, such as methanol or nitrate, or hazardous material, such as methane or propane, were eliminated, for environmental and health/safety reasons. Finally, aerobic biodegradation processes were eliminated because they were not deemed effective on tetrachloroethene or trichloroethene.

**Comment No. 2:** Compliance with South Carolina Solid Waste Regulations for Municipal Landfills (R.61-107.258) is presented in the Feasibility Study Report (Table 3.2) as "Relevant and Appropriate," but not "Applicable."

The basic design components for final cover and landfill gas control appear to generally meet state requirements. Two types of liner systems are evaluated: a soil cover, and a flexible membrane liner (FML). Based on HELP model calculations in the Feasibility Study Report,

there is a marked difference in the predicted amount of infiltration that will occur between these two systems (soil cover produces > 14 million gallons of leachate per year; FML at  $10^{-9}$  cm/sec permeability produces < 200,000 gallons of leachate per year). Most of the developed alternatives incorporate use of the FML capping system. However, the Feasibility Study Report leaves open the type of liner to be selected in the final design. The HELP model presented in the Feasibility Study Report relies upon a very low permeability value ( $10^{-9}$  cm/sec) which is applicable to a geo-composite liner. The final design should be critically reviewed to confirm that the criteria serving as the basis for remedy selection is maintained in the design. Of the four liner types presented, there are concerns with the long-term durability of liner low density polyethylene (LLDPE) or very low density polyethelene (VLDPE) materials, especially if a traffic road is going to be constructed.

**RESPONSE:** As the comment recommends, the remedial design (RD) will be critically reviewed, as it develops and is evaluated by EPA and SCDHEC, to confirm that the criteria serving as the basis for remedy selection is maintained in the design. In the Feasibility Study (FS), the HELP model was based on a permeability value of  $10^{-9}$  cm/sec, which is the typical permeability of a geosynthetic clay liner, one of the FML options cited in the report. Because the plastic sheeting has essentially no permeability, the permeability of the geosynthetic liner was chosen in order to be conservative.

The FS incorporated a capping alternative that included a corridor for a possible future road. The location of the corridor was selected because the volume of waste is minimal along that path. The Feasibility Study assumed that all of the waste would be removed from that area; therefore, the FML cap would not be installed over any areas containing waste.

Several flexible membrane liner (FML) materials were listed in the Feasibility Study. Linear Low Density Polyethylene and Very Low Density Polyethylene were included with others in order to give the designer flexibility in selecting the appropriate FML material, while maintaining the intended permeability standard.

**Comment No. 3:** A 3 (horizontal) to 1 (vertical) side-slope is proposed along the landfill margins in the eastern portion of the Arkwright Dump Site. This is generally "acceptable maximum" design value and appears to be used in the Arkwright Feasibility Study Report design primarily based on existing waste distribution. However, use of this design value in remedy implementation raises the following issues:

- 3(a). The areas that exhibit a 3:1 slope along the northern and eastern boundaries are immediately adjacent to surface water streams. This could present a concern as the structural integrity of these areas could be compromised under high storm flow conditions in the streams. The steep slope along the northern property line may also cause water to rise to a greater elevation on adjacent properties under storm flow conditions.

**RESPONSE:** The FS capping alternatives brought forward (and the cap option included within Alternative 6, the Selected Remedy) includes moving approximately 50,000 cubic yards of landfill materials in order to develop a 20-foot buffer zone between the edge of the cap and the property lines, and to achieve 3:1 slopes. Maps (see Figs. 2.1 and 4.2, FS) indicate more than 40-50 feet between the property line and the tributary on the north Site boundary, and that the waste-edge limit is no closer than approximately 50 feet to Fairforest Creek. These distances, plus the 20-foot buffer zone, should prevent the landfill from being the cause of any damage during periods of high flow in the streams. During the development of the RD, EPA will ensure that the requirements for erosion control and runoff control include robust and appropriate measures on the capped waste areas along stream boundaries.

- 3(b). Since minimal waste consolidation is included in the proposed alternative, there may not be sufficient space available to implement storm water diversion structures along the toe of the newly capped landfill. It appears that storm water would sheet-flow directly from the landfill surface into the adjacent streams, potentially exacerbating the influence of a high storm flow from the landfill to adjacent properties.

**RESPONSE:** EPA believes the waste consolidation contemplated in the action is considerably more than minimal; as noted, approximately 50,000 cubic yards of landfill materials, and 12,000 cubic yards in the "burn mound" area (northeast corner), will be moved and consolidated. The response above, concerning distances and erosion controls, addresses this comment as well. The measures should be effective in minimizing any storm/high-flow problems. We agree that the need for functional erosion and runoff controls is highly important, and we will ensure that the RD is successful in this regard.

- 3(c). A road placed onto the landfill cap, developed as a design option for the cap, could increase the storm flow into the streams and further exacerbate erosion issues along the sloped Dump Site boundaries. The FS (Section 4.5) notes "community support" for this structure.

**RESPONSE:** Assuming the potential road corridor is retained in the RD, there will be no waste remaining in the corridor area, since it will have been moved. Vegetation and diversion ditches would be used to manage the storm water in the corridor. If a road is designed and constructed across the corridor, the storm water generated by that road will have to be addressed during the design of that road, and this should present only minimal problems.

**Comment No. 4:** The extent of the cap (and potentially the waste also) appears to be depicted on conceptual drawings presented in the Feasibility Study Report as extending onto adjacent properties. Issues with slope stability and storm water management could be addressed if waste relocation and surface contouring would be incorporated into the cap design, to more evenly distribute the waste across the entire footprint of the waste area. The final contouring could then be designed to reduce the severe slopes in the eastern portion of the landfill. Minimally, to

address these issues outlined in Comment #3 above, any remedy should pull back waste from the northern and eastern edges.

**RESPONSE:** The property lines in the FS figures are approximate; however, the comment is correct in the interpretation that the area underlain by wastes likely extends beyond the Site boundaries in some areas. The FS option brought forward and selected in the remedy presumes that the landfill materials will be consolidated on to the body of the landfill to develop a 20-foot buffer zone between the cap and the property boundaries, and between the cap edge and surface water. The slopes will be contoured to 3:1. The consolidation of waste will require moving approximately 50,000 cubic yards of landfill materials around the slopes and about 12,000 cubic yards from the "burn mound."

**Comment No. 5:** Hydrogen-Release Compound (HRC) treatment could be an appropriate technology for groundwater remediation of chlorinated VOCs. A high degree of natural breakdown of tetrachloroethene and trichloroethene to daughter products has already occurred and providing an electron acceptor to enhance the anaerobic biodegradation process would likely be successful.

We have the following concerns regarding the development of this alternative in the Feasibility Study Report and Proposed Plan:

- 5(a). The identified HRC treatment zone is not continuous, with a non-treated area in the east-central part of the landfill shown. This could be a remnant of monitoring well placement, and may need to be addressed in the remedy design.

**RESPONSE:** For comparison at the FS stage, Alternative 6 focused the groundwater treatment on the highest known concentrations of contaminants nearest the sources. Also taken into account was the lack of any surface water or groundwater detections (creek bed) in a long segment of Fairforest Creek, from just east of MW-2, down to the southeast property corner, and the relatively unimpacted well MW-3. The issue of where to effect the treatment will be addressed further in the Treatability Study.

- 5(b). The estimated number of injection points and the capital costs to implement an HRC program look low, by a factor of two or more based on recent pilot project experience and estimates for full-scale application in similar geology.

**RESPONSE:** The commenter's estimate could be correct; it is difficult to accurately estimate the necessary number of injection points and the costs. EPA will take this into consideration in the RD. However, the effectiveness, cost, and other comparisons made in the Record of Decision still hold overall, and are still correct.

- 5(c). The argument to delay HRC pilot implementation until after the landfill cap is placed is not strongly supported. The pilot would be expected to take 6 to 9 months and could be

address these issues outlined in Comment #3 above, any remedy should pull back waste from the northern and eastern edges.

**RESPONSE:** The property lines in the FS figures are approximate; however, the comment is correct in the interpretation that the area underlain by wastes likely extends beyond the Site boundaries in some areas. The FS option brought forward and selected in the remedy presumes that the landfill materials will be consolidated on to the body of the landfill to develop a 20-foot buffer zone between the cap and the property boundaries, and between the cap edge and surface water. The slopes will be contoured to 3:1. The consolidation of waste will require moving approximately 50,000 cubic yards of landfill materials around the slopes and about 12,000 cubic yards from the "burn mound."

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We have the following concerns regarding the development of this alternative in the Feasibility Study Report and Proposed Plan:

- 5(a). The identified HRC treatment zone is not continuous, with a non-treated area in the east-central part of the landfill shown. This could be a remnant of monitoring well placement, and may need to be addressed in the remedy design.

**RESPONSE:** For comparison at the FS stage, Alternative 6 focused the groundwater treatment on the highest known concentrations of contaminants nearest the sources. Also taken into account was the lack of any surface water or groundwater detections (creek bed) in a long segment of Fairforest Creek, from just east of MW-2, down to the southeast property corner, and the relatively unimpacted well MW-3. The issue of where to effect the treatment will be addressed further in the Treatability Study.

- 5(b). The estimated number of injection points and the capital costs to implement an HRC program look low, by a factor of two or more based on recent pilot project experience and estimates for full-scale application in similar geology.

**RESPONSE:** The commenter's estimate could be correct; it is difficult to accurately estimate the necessary number of injection points and the costs. EPA will take this into consideration in the RD. However, the effectiveness, cost, and other comparisons made in the Record of Decision still hold overall, and are still correct.

- 5(c). The argument to delay HRC pilot implementation until after the landfill cap is placed is not strongly supported. The pilot would be expected to take 6 to 9 months and could be

completed during cap design. Construction of the cap itself would not be expected to alter the groundwater conditions in the short-term. Adding the cap may improve the HRC treatment by creating a more anaerobic aquifer environment although this would be expected to take years to occur.

**RESPONSE:** The Selected Remedy, as described in Section L of this Record of Decision, allows the Treatability Study to be initiated before cap construction is complete, but states that the Treatability Study must focus on the groundwater situation under the cap, once installed. The remedy maintains flexibility under which the Treatability Study can be planned, and proceed, as observations and decisions are made about the underlying groundwater. The effect of the cap itself, on infiltration and contaminant leaching, should not be discounted.

**5(d).** As currently outlined, the preferred remedy does not appear to address elevated concentrations of VOCs in the bedrock portion of the aquifer. HRC treatment could be extended into bedrock, although its success would be dependent on direct knowledge of the underlying fractured flow system.

**RESPONSE:** The Proposed Plan (page 3) notes deep contamination in well MW-4D; and EPA's Project Manager stated verbally at the public meeting that contamination was present in the deeper bedrock wells, and that the remedy must address that contamination. EPA believes this was understood by the public. The Treatability Study will include planning for treatment in the fractured bedrock.

Nine (9) comments concerned the Baseline Human Health Risk Assessment.

**Comment No. 6:** Table 2.1, Summary of Surface Soil Screening, indicates that manganese is not retained as a constituent of potential concern (COPC). The maximum detected concentration listed for manganese in Table 2.1 is greater than the adjusted (HQ=0.1) Region IX PRG for residential exposures. Likewise, manganese is named as a human health COPC in the narrative of Section 2.5.1. Table 2.7, Chemicals of Potential Concern (Human Health) does not list manganese as a human health COPC. Please clarify the status of manganese as a human health COPC.

**RESPONSE:** As commenter notes, Section 2.5.1 states that manganese exceeds the Region 9 PRG (1/10). It should also have explained, however, that manganese was not detected at greater than 2 times background, and in accordance with RI/FS guidance, is not Site-attributed. This error was uncorrected from an earlier version of the document. In this case and for several of the comments below, EPA was aware of this error but elected to approve the document nonetheless, because it is not judged significant in terms of decision-making for the Site remedy.

**Comment No. 7:** Table 2.1, Summary of Surface Soil Screening, indicates in footnotes that selenium is not included as a human health COPC in risk determinations but will be considered in

any remedy selection. Selenium is included in the noncarcinogenic and carcinogenic calculations for exposures to soil as presented in Appendix C.

**RESPONSE:** Selenium should not have appeared in Appendix C. Its maximum detection was below 1/10 the PRG. However, comments from EPA had directed that it be retained for consideration because the maximum detection was above the Soil Screening Level for Dilution-Attenuation Factor = 1, indicating the potential to leach to groundwater.

**Comment No. 8:** There are inconsistencies in the exposure point concentration for the soil COPCs; DDT, DDE, and cadmium listed in Table 2.1 and the risk and hazard calculation tables presented in Appendix C.

**RESPONSE:** There were typographical errors in Table 2.1 involving those analytes. The values in Appendix C are correct.

**Comment No. 9:** The source of the sediment exposure point concentrations for arsenic and chromium in the risk and hazard calculation tables presented in Appendix C is not clear.

**RESPONSE:** The error was that the concentrations are in the wrong units, they should have been presented as milligrams.

**Comment No. 10:** The surface water COPCs presented in Table 2.7 are inconsistent with constituents presented in surface water risk and hazard calculation tables presented in Appendix C.

**RESPONSE:** EPA cannot confirm the possible error noted here. Three substances are named on Table 2.7 and all three appear in the appropriate table in Appendix C. PCE and manganese have noncarcinogenic effects, while PCE and dioxin have carcinogenic effects.

**Comment No. 11:** The groundwater COPCs presented in table 2.7 are inconsistent with constituents presented in the groundwater risk and hazard calculations tables presented in Appendix C.

**RESPONSE:** Chromium should have been retained in Table 2.7. The constituents in the tables in Appendix E are the correct ones that should have had calculations performed. EPA was aware of the error.

**Comment No. 12:** The USEPA has noted in associated site documentation that "Fairforest Creek is a fishery." A completed fish consumption exposure pathway is not included for current/future recreational receptors or the future residential receptors. Please provide the rationale for the absence of a quantitative evaluation of this potential pathway.

**RESPONSE:** During Site Assessment work, local or state officials are contacted to determine whether a surface water body is a fishery. Making preliminary Hazard Ranking System (HRS) determinations does not require that evidence of fishing or shellfish-harvesting be present on the site. At the RI/FS stage, however, a risk management decision is made about whether or not a fish- or shellfish-consumption scenario is appropriate for consideration in the Baseline Risk Assessment. No evidence of fishing was present on the property, and residents did not indicate that this was occurring. EPA did not, therefore, include this scenario in the assessment.

**Comment No. 13:** There are a number of statements in the discussion section that suggest off-site sources for some of the chemicals screened (e.g. the discussion of dioxin and metals in sediment). These discussions do not take into account (a) potential wind dispersion of dioxin from the burn mound at the Arkwright Dump and (b) the possibility that groundwater flow from the dump may, in fact, contribute to the metals found at SD-04.

**RESPONSE:** EPA acknowledges, as does the FS, that the Site is a likely source for groundwater and other contaminants in Fairforest creek water, northeast, and southeast, of the Site. In sediment, origins are difficult to pin down. Dioxin was present in the RI background sample, upstream of both IMC and the Site; there are any number of reasonable potential sources for dioxins in the area. The Arkwright Dump Site, with municipal wastes and in view of local accounts of fires, can certainly be a source of dioxins, but EPA believes that attributing specific dioxin detections to specific origins is not possible based on present data (both from the Site and nearby properties). Wind dispersion of contaminants is reasonable to assume, but would equally affect any exposed areas of contaminated soils, including those at higher elevation and away from the Site. Again, there are any number of reasonable potential sources for dioxins in the area, including any areas where burning took place on the ground, for virtually any purpose.

Regarding groundwater flow and contributing metals to sediment sample SD-04, while this may be possible, the idea is not supported by groundwater data from Site wells on the east side of the Site (nearest the creek). The wells do not show any significant metals detections, thus giving no reason to propose the Site as the origin.

**Comment No. 14:** Although not required for completion of a risk assessment, the Human Health Risk Assessment Report does not include standardized tables consistent with Risk Assessment Guidance for Superfund (RAGS); Standardized Planning, Reporting, and Review of Superfund Risk Assessment (Part D; Interim USEPA, 1998). Please clarify whether approval of this modified approach represents a change in region 4 guidance and practice or is based on site-specific considerations.

**RESPONSE:** EPA reviews of the drafts, and the finalized, Baseline Risk Assessment recognized the difference between the tables presented and those in the Risk Assessment Guidance for Superfund (RAGS), Part D. As noted, the format is not required for EPA to approve the completion of a risk assessment. Approval was provided for this site only, and does not represent a change in EPA Region 4 risk assessment guidance or policy.

The final five (5) comments concerned the Screening Ecological Risk Assessment Report.

**Comment No. 15:** Although we generally agree that the approach presented in the document to arrive at preliminary ecological constituents of potential concern (COPCs) represents a reasonable approach to identifying those compounds expected to potentially pose ecological risk, the following screening methodologies do represent a deviation from Region 4 ecological screening guidance, precedence, and practice.

- A. Detected constituents without published Region 4 ecological screening values are not maintained as preliminary ecological COPCs.
- B. Constituents that were not detected, where the detection limit exceeds a screening value or where no screening value is available, are not maintained as preliminary ecological COPCs.

Please clarify whether approval of these modified screening methodologies represents a change in Region 4 ecological screening guidance and practice or is based on site-specific considerations.

**RESPONSE:** Comment states that a number of detected constituents were “not maintained as preliminary ecological COPCs.” The report has no table listing the preliminary ecological COPCs retained, because EPA did not require the PRP Contractor to prepare an additional report documenting the start of step 3, problem formulation (Guidance section 3). At step 3.2, on page 3-3, all of the constituents with HQs shown in Tables 3, 4, 5, and 6 of the report would have been eliminated (“Refinement of COPCs” step). Based on review by the assigned ecological toxicologist in the Office of Technical Services, the RPM decided to approve the document because it was determined to be sufficient for the necessary risk management and site management decisions to be made. Approval was for this site only, and does not represent a change in EPA Region 4 ecological risk assessment guidance or policy.

**Comment No. 16:** The text indicates that Van den Berg et al. (1988) was used to assess the toxicity equivalent factors for the dioxin and furan congeners. However, media-specific data tables do not include a presentation of dioxin toxicity equivalent concentrations (TEQs) for mammalian, avian, and fish species.

**RESPONSE:** The comment is correct, the TEQ values should have been included in the tables.

**Comment No. 17:** The text indicates that no screening value is available for dioxin/furans in sediment. This is incorrect. Beginning in August 11, 1999, Region 4's Ecological Risk Assessment Bulletins—Supplement to RAGS located at <http://www.epa.gov/region4/waste/ots/ecolbul.htm> has included an ecological screening value for dioxin in sediment (see Table 3). The dioxin ecological screening value for sediment is 2.5 ng/kg and is taken from *Interim Report on Data and Methods for Assessment of 2,3,7,8 -*

*Tetrachlorodibenzo-p-dioxin Risks to Aquatic Life and Associated Wildlife* EPA/600/R-93/055 (USEPA, 1993).

**RESPONSE:** The comment is correct, the screening value is available. The screening value is a toxicity equivalent quotient (TEQs), and should be in the table for each sample.

**Comment No. 18:** The United States Environmental Protection Agency (USEPA) approval letter, dated September 11, 2002, which accompanies the report documents the scientific management decision point (SMDP) recommended in the ecological risk assessment process following Steps 1 and 2. Please clarify whether the conclusion that "the proposed Site remedy will not need a separate action to address ecosystem restoration" also indicates that additional ecological risk evaluations are not indicated based on the results of the Screening Ecological Risk Assessment activities conducted to date.

**RESPONSE:** As stated, EPA did not require the PRP Contractor to prepare an additional report documenting the elimination of the constituents with HQs shown in Tables 3, 4, 5, and 6 of the report. The conclusion that no additional ecological risk evaluation was necessary preceded considerations about whether the Site remedy would need to address ecosystem restoration. These decisions apply to this site only, and do not represent a change in EPA Region 4 ecological risk assessment guidance or policy.

**Comment No. 19:** The USEPA approval letter, dated September 11, 2002, which accompanies the report provides rationale for the SMDP based on surface water considerations and soil considerations (i.e., presumptive remedy). Can the SMDP be supplemented to include the agency's rationale with respect to sediment considerations?

**RESPONSE:** The approval letter itself, dated September 11, 2002, cannot be altered or amended at this time. As noted, the letter focused on surface water and soil considerations, but could have noted a sediment rationale as well. Among the detected constituents, one (chromium) had an HQ >1.0. This constituent also would have been eliminated in the "Refinement of COPCs" step. Conclusions about the lack of significant sediment detections were unchanged.

**APPENDIX B**  
**SUPPLEMENTAL RISK ASSESSMENT INFORMATION**

**RECORD OF DECISION  
ARKWRIGHT DUMP SITE, SPARTANBURG, SOUTH CAROLINA  
APPENDIX B  
SUPPLEMENTAL RISK ASSESSMENT INFORMATION**

The tables presented in this appendix are excerpted from the following document:

“Human Health Risk Assessment for Arkwright Dump,”  
Fletcher Group, Greenville, SC, September 2002

**TABLE 3.1**  
**INCIDENTAL SOIL INGESTION DURING RECREATION**

**Equation :**

$$\text{Intake} \left( \frac{\text{mg}}{\text{kg} \cdot \text{day}} \right) = \frac{\text{CS} \times \text{IR} \times \text{CF} \times \text{FI} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

**Equation :**

- CS** = Contaminant Concentration in Sediment (mg/kg)  
**IR** = Incidental Ingestion Rate of Soil (mg/day)  
**CF** = Conversion factor ( $10^{-6}$  kg/mg)  
**FI** = Fraction Ingested (1.0 for surface soil)  
**EF** = Exposure Frequency (days/year)  
**ED** = Exposure Duration (years)  
**BW** = Body Weight (kg)  
**AT** = Averaging Time (period over which exposure is averaged -- days)

**Assumptions:**

- CA:** Site-specific measured value. Highest concentration.  
  
**IR:** 200 mg/day for the child (1-6) [US EPA, 1991b]  
 100 mg/day for age groups >6 [US EPA, 1991b]  
  
**EF:** 78 days/year [2 visits per week – 39 weeks]  
  
**ED:** 70 years (lifetime by convention [US EPA, 1991b]  
 30 years at one residence for adults [US EPA, 1991b]  
 6 years for the children (1-6) and (7-12) [US EPA, 1991b]  
  
**BW:** 15 kg for the child (1-6) [US EPA, 1991b]  
 27 kg for the child (1-6) [Assumed]  
 70 kg for the child [US EPA, 1991b]  
  
**AT:** ED x 365 days/year for noncarcinogenic risk  
 70 years x 365 days/year for carcinogenic risk

**TABLE 3.2**  
**DERMAL ABSORPTION FROM SOIL DURING RECREATION**

**Equation :**

$$\text{Intake} \left( \frac{\text{mg}}{\text{kg-day}} \right) = \frac{\text{CS} \times \text{CF} \times \text{SA} \times \text{AF} \times \text{ABS} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

**Equation :**

- CS** = Contaminant Concentration in Soil (mg/kg)  
**CF** = Conversion factor ( $10^{-6}$  kg/mg)  
**SA** = Skin Surface Available for Contact ( $\text{cm}^2$ )  
**AF** = Sediment Adherence Factor ( $\text{mg}/\text{cm}^2$ )  
**ABS** = Dermal Absorption Factor (Unitless)  
**EF** = Exposure Frequency (days/year)  
**ED** = Exposure Duration (years)  
**BW** = Body Weight (kg)  
**AT** = Averaging Time (period over which exposure is averaged -- days)

**Assumptions:**

- CA:** Site-specific measured value. Highest concentration.  
**SA:** 1,780  $\text{cm}^2$  for the child (1-6)  
       3,020  $\text{cm}^2$  for the child (7-12)  
       4,720  $\text{cm}^2$  for adult  
       (50<sup>th</sup> percentile of 1/2 legs, 1/2 arms and hands [US EPA, 1991b])  
**AF:** 0.2  $\text{mg}/\text{cm}^2$  [US EPA, 2000c]  
**ABS:** 0.01 for organic compounds [US EPA, 1992]  
       0.001 for inorganic compounds [US EPA, 1992]  
**EF:** 78 days/year [2 visits per week – 39 weeks]  
**ED:** 70 years (lifetime by convention) [US EPA, 1991b]  
       30 years at one residence (7-12) [US EPA, 1991b]  
       6 years for the children (1-6) and (7-12) [US EPA, 1991b]  
**BW:** 15 kg for the child (1-6) [US EPA, 1991b]  
       27 kg for the child (1-6) [Assumed]  
       70 kg for the child [US EPA, 1991b]  
**AT:** ED x 365 days/year for noncarcinogenic risk  
       70 years x 365 days/year for carcinogenic risk

**TABLE 3.3**  
**INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS DURING RECREATION**

**Equation :**

$$\text{Intake} \left( \frac{\text{mg}}{\text{kg-day}} \right) = \frac{\text{CA} \times \text{IR} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

**Equation :**

**CA = Contaminant Concentration in Air (mg/M<sup>3</sup>)**  
**IR = Inhalation Rate (M<sup>3</sup>/hour)**  
**ET = Exposure Time (hours/day)**  
**EF = Exposure Frequency (days/year)**  
**ED = Exposure Duration (years)**  
**BW = Body Weight (kg)**  
**AT = Averaging Time (period over which exposure is averaged -- days)**

**Variable Values:**

**CA:** Site-specific measured or modeled value.

**IR:** 1.2 M<sup>3</sup>/hour child short term moderate [US EPA, 1997e]  
1.6 M<sup>3</sup>/hour adult short term moderate [US EPA, 1997e]

**ET:** 2.6 hours/day extrapolated from swimming [US EPA, 1989]

**EF:** 78 days/year [2 visits per week – 39 weeks]

**ED:** 6 years for the child (1-6) and (7-12) [US EPA, 1991b]  
30 years at one residence (7-12) [US EPA, 1991b]

**BW:** 27 kg child (7-12) - [Assumed]  
70 kg adult [US EPA, 1991b]

**AT:** ED x 365 days/year for noncarcinogenic risk  
70 years x 365 days/year for carcinogenic risk

**TABLE 3.4**  
**INCIDENTAL WATER INGESTION WHILE WADING**

**Equation :**

$$\text{Intake} \left( \frac{\text{mg}}{\text{kg-day}} \right) = \frac{\text{CW} \times \text{IR} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

**Equation :**

**CW = Contaminant Concentration in Surface Water (mg/L)**  
**IR = Incidental Ingestion Rate of surface water (L/hour)**  
**ET = Exposure Time (hours/day)**  
**EF = Exposure Frequency (days/year)**  
**ED = Exposure Duration (years)**  
**BW = Body Weight (kg)**  
**AT = Averaging Time (period over which exposure is averaged -- days)**

**Assumptions:**

**CA: Site-specific measured value. Highest concentration.**

**IR: 0.05 L/hour for the child (7-12) wading extrapolated from swimming [US EPA, 1989]**

**ET: 2.6 hours/day for the child (7-12) wading [US EPA, 1989]**

**EF: 45 days/year for the child (7-12) wading extrapolated from swimming [US EPA, 2000c]**

**ED: 6 years for the child (7-12) [US EPA, 1991b]**

**BW: 27 kg for the child (7-12) [Assumed]**

**AT: ED x 365 days/year for noncarcinogenic risk  
70 years x 365 days/year for carcinogenic risk**

TABLE 3.5  
DERMAL ABSORPTION FROM SURFACE WATER WHILE WADING

Equation :

$$\text{Intake} \left( \frac{\text{mg}}{\text{kg} \cdot \text{day}} \right) = \frac{\text{CW} \times \text{SA} \times K_p \times \text{CR} \times \text{ET} \times \text{EF} \times \text{ED} \times \text{CF}}{\text{BW} \times \text{AT}}$$

Equation :

CW = Contaminant Concentration in Surface Water (mg/L)  
SA = Skin Surface Available for Contact (cm<sup>2</sup>)  
K<sub>p</sub> = Chemical-specific dermal permeability coefficient (cm/hr)  
ET = Exposure Time (hours/day)  
EF = Exposure Frequency (days/year)  
ED = Exposure Duration (years)  
CR = Volumetric conversion factor for water (1 L/1000 cm<sup>3</sup>)  
BW = Body Weight (kg)  
AT = Averaging Time (period over which exposure is averaged -- days)

Assumptions:

CA: Site-specific measured value. Highest concentration.

SA: 3,020 cm<sup>2</sup> for the child wading (50<sup>th</sup> percentile of ½ legs, ½ arms and hands for child (9-10) [US EPA, 1991b]

ET: 2.6 hours/day for the child (7-12) wading [US EPA, 1989]

EF: 45 days/year for the child (7-12) wading extrapolated from swimming [US EPA, 2000c]

ED: 6 years for the child (7-12) [US EPA, 1991b]

BW: 27 kg for the child (7-12) [Assumed]

AT: ED x 365 days/year for noncarcinogenic risk  
70 years x 365 days/year for carcinogenic risk

K<sub>p</sub>: : Manganese 0.01 cm/hr [US EPA, 1992]  
Tetrachloroethene 0.048 cm/hr  
Dioxins and Furans 1.4 cm/hr

**TABLE 3.6**  
**INCIDENTAL SEDIMENT INGESTION WHILE WADING**

**Equation :**

$$\text{Intake} \left( \frac{\text{mg}}{\text{kg-day}} \right) = \frac{\text{CS} \times \text{IR} \times \text{CF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

**Equation :**

- CS** = Contaminant Concentration in Sediment (mg/kg)  
**IR** = Incidental Ingestion Rate of surface water (mg/day)  
**CF** = Conversion factor ( $10^{-6}$  kg/mg)  
**EF** = Exposure Frequency (days/year)  
**ED** = Exposure Duration (years)  
**BW** = Body Weight (kg)  
**AT** = Averaging Time (period over which exposure is averaged -- days)

**Assumptions:**

- CA:** Site-specific measured value. Highest concentration.  
**IR:** 100 mg/day for the child (7-12) wading [US EPA, 1991b]  
**EF:** 45 days/year for the child (7-12) wading extrapolated from swimming [US EPA, 2000c]  
**ED:** 6 years for the child (7-12) [US EPA, 1991b]  
**BW:** 27 kg for the child (7-12) [Assumed]  
**AT:** ED x 365 days/year for noncarcinogenic risk  
       70 years x 365 days/year for carcinogenic risk

TABLE 3.7  
DERMAL ABSORPTION FROM SEDIMENT WHILE WADING

Equation :

$$\text{Intake} \left( \frac{\text{mg}}{\text{kg-day}} \right) = \frac{\text{CS} \times \text{CF} \times \text{SA} \times \text{AF} \times \text{ABS} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

Equation :

CS = Contaminant Concentration in Sediment (mg/kg)  
CF = Conversion factor ( $10^{-6}$  kg/mg)  
SA = Skin Surface Available for Contact ( $\text{cm}^2$ )  
AF = Sediment Adherence Factor ( $\text{mg}/\text{cm}^2$ )  
ABS = Dermal Absorption Factor (Unitless)  
EF = Exposure Frequency (days/year)  
ED = Exposure Duration (years)  
BW = Body Weight (kg)  
AT = Averaging Time (period over which exposure is averaged -- days)

Assumptions:

CA: Site-specific measured value. Highest concentration.

SA:  $3,020 \text{ cm}^2$  for the child wading (50<sup>th</sup> percentile of  $\frac{1}{2}$  legs,  $\frac{1}{2}$  arms and hands for child (9-10) [US EPA, 1991b]

AF:  $0.2 \text{ mg}/\text{cm}^2$  [US EPA, 2000c]

ABS: 0.01 for organic compounds [US EPA, 1992]  
0.001 for inorganic compounds [US EPA, 1992]

EF: 45 days/year for the child (7-12) wading extrapolated from swimming [US EPA, 2000c]

ED: 6 years for the child (7-12) [US EPA, 1991b]

BW: 27 kg for the child (7-12) [US EPA, 1991b]

AT: ED x 365 days/year for noncarcinogenic risk  
70 years x 365 days/year for carcinogenic risk

**TABLE 3.8**  
**INGESTION OF GROUNDWATER**

**Equation :**

$$\text{Intake} \left( \frac{\text{mg}}{\text{kg-day}} \right) = \frac{\text{CW} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

**Equation :**

**CW** = Contaminant Concentration in Surface Water (mg/L)  
**IR** = Incidental Ingestion Rate of surface water (L/hour)  
**EF** = Exposure Frequency (days/year)  
**ED** = Exposure Duration (years)  
**BW** = Body Weight (kg)  
**AT** = Averaging Time (period over which exposure is averaged -- days)

**Assumptions:**

**CW:** Site-specific measured value. Highest concentration.

**IR:** 1 L/Day for the child (1-12) [US EPA, 1991b]  
 2 L/Day for the child (7-12) [US EPA, 1991b]  
 2 L/Day for the adult [US EPA, 1991b]

**EF:** 350 days/year  
 [US EPA, 1991a]

**ED:** 6 years for the child (1-6) [US EPA, 1991b]  
 6 years for the child (7-12) [US EPA, 1991b]  
 18 years for the adult [US EPA, 1991b]

**BW:** 15 kg for the child (1-6) [US EPA, 1991b]  
 27 kg for the child (7-12) [Assumed]  
 70 kg for the adult [US EPA, 1991b]

**AT:** ED x 365 days/year for noncarcinogenic risk  
 70 years x 365 days/year for carcinogenic risk

TABLE 3.9  
DERMAL ABSORPTION FROM GROUNDWATER WHILE SHOWERING

Equation :

$$\text{Intake} \left( \frac{\text{mg}}{\text{kg-day}} \right) = \frac{\text{CW} \times \text{SA} \times \text{K}_p \times \text{ET} \times \text{EF} \times \text{ED} \times \text{CF}}{\text{BW} \times \text{AT}}$$

Equation :

**CW** = Contaminant Concentration in Surface Water (mg/L)  
**SA** = Skin Surface Available for Contact (cm<sup>2</sup>)  
**K<sub>p</sub>** = Chemical-specific dermal permeability coefficient (cm/hr)  
**ET** = Exposure Time (hours/day)  
**EF** = Exposure Frequency (days/year)  
**ED** = Exposure Duration (years)  
**CF** = Volumetric conversion factor for water (1 L/1000 cm<sup>3</sup>)  
**BW** = Body Weight (kg)  
**AT** = Averaging Time (period over which exposure is averaged -- days)

Assumptions:

**CA:** Site-specific measured value. Highest concentration.

**SA:** 7,200 cm<sup>2</sup> for the child (1-7) [US EPA, 1989]  
10,500 cm<sup>2</sup> for the child (7-12) [US EPA, 1989]  
18,200 cm<sup>2</sup> for the adult [US EPA, 1989]

**ET:** 0.14 hours/day for the child showering [California EPA, 1994]  
0.25 hours/day for the adult showering [California EPA, 1994]

**EF:** 350 days/year

**ED:** 6 years for the child (1-6) [US EPA, 1991b]  
6 years for the child (7-12) [US EPA, 1991b]  
18 years for the adult [US EPA, 1991b]

**BW:** 15 kg for the child (1-6) [US EPA, 1991b]  
27 kg for the child (7-12) [Assumed]  
70 kg for the adult [US EPA, 1991b]

**AT:** ED x 365 days/year for noncarcinogenic risk  
70 years x 365 days/year for carcinogenic risk

**TABLE 3.10**  
**INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS WHILE SHOWERING**

**Equation :**

$$\text{Intake} \left( \frac{\text{mg}}{\text{kg-day}} \right) = \frac{\text{CA} \times \text{IR} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

**Equation :**

**CA** = Contaminant Concentration in Air (mg/M<sup>3</sup>)  
**IR** = Inhalation Rate (M<sup>3</sup>/hour)  
**ET** = Exposure Time (hours/day)  
**EF** = Exposure Frequency (days/year)  
**ED** = Exposure Duration (years)  
**BW** = Body Weight (kg)  
**AT** = Averaging Time (period over which exposure is averaged -- days)

**Variable Values:**

**CA:** Site-specific measured concentration in groundwater  
times the Henry's constant.

**IR:** 0.6 M<sup>3</sup>/hr for all groups while showering [US EPA, 1989]

**ET:** 0.14 hours/day for the child showering [California EPA, 1994]  
0.25 hours/day for the adult showering [California EPA, 1994]

**EF:** 350 days/year

**ED:** 6 years for the child (1-6) [US EPA, 1991b]  
6 years for the child (7-12) [US EPA, 1991b]  
18 years for the adult [US EPA, 1991b]

**BW:** 15 kg for the child (1-6) [US EPA, 1991b]  
27 kg for the child (7-12) [Assumed]  
70 kg for the adult [US EPA, 1991b]

TABLE 3.11  
CHILD (AGE 1-6) EXPOSURE DURATION AVERAGED DOSES  
CURRENT RECREATIONAL VISITOR

CHEMICALS	Landfill Gas mg/kg-day	Soil Ingestion mg/kg-day	Soil Absorption mg/kg-day	Total mg/kg-day
Manganese	-	1.42E-03	2.54E-06	1.43E-03
Antimony	-	3.13E-05	5.58E-08	3.14E-05
Arsenic	-	3.42E-05	3.04E-06	3.72E-05
Barium	-	2.08E-03	3.70E-06	2.08E-03
Cadmium	-	6.55E-06	1.17E-08	6.57E-06
Copper	-	1.57E-03	2.79E-06	1.57E-03
Cyanide	-	1.52E-05	2.71E-06	1.80E-05
Selenium	-	1.99E-05	3.55E-08	2.00E-05
Zinc	-	3.42E-03	6.09E-06	3.43E-03
Benzene	7.51E-05	-	-	7.51E-05
Chlorobenzene	1.96E-05	-	-	1.96E-05
Chloroethane	1.20E-07	-	-	1.20E-07
Chloromethane	1.60E-06	-	-	1.60E-06
Dieldrin	-	2.85E-08	2.54E-09	3.10E-08
4,4'-DDT	-	7.86E-08	7.00E-09	8.56E-08
<i>p</i> -Dichlorobenzene	4.13E-06	-	-	4.13E-06
Dichlorodifluoromethane	3.33E-06	-	-	3.33E-06
<i>cis</i> -1,2-Dichloroethene	1.20E-06	-	-	1.20E-06
Ethylbenzene	7.82E-06	-	-	7.82E-06
Methylene Chloride	1.20E-07	-	-	1.20E-07
Tetrachloroethene	1.02E-06	-	-	1.02E-06
Toluene	1.20E-06	-	-	1.20E-06
Trichloroethene	1.24E-05	-	-	1.24E-05
Trichlorofluoromethane	3.02E-07	-	-	3.02E-07
Trimethylbenzene	2.04E-05	-	-	2.04E-05
Vinyl Chloride	5.78E-06	-	-	5.78E-06
Xylenes	2.10E-05	-	-	2.10E-05

TABLE 3.12  
CHILD (AGE 7-12) EXPOSURE DURATION AVERAGED DOSES  
CURRENT RECREATIONAL VISITOR

CHEMICALS	Landfill Gas mg/kg-day	Surface Water Ingestion mg/kg-day	Surface Water Absorption mg/kg-day	Sediment Ingestion mg/kg-day	Sediment Absorption mg/kg-day	Soil Ingestion mg/kg-day	Soil Absorption mg/kg-day	Total mg/kg-day
Manganese	-	9.50E-05	5.74E-05	-	-	3.96E-04	2.39E-06	5.50E-04
Antimony	-	-	-	-	-	8.71E-06	5.26E-08	8.76E-06
Arsenic	-	-	-	2.37 x 10 <sup>-6</sup>	1.43 x 10 <sup>-8</sup>	9.50E-06	2.87E-06	1.48 x 10 <sup>-5</sup>
Barium	-	-	-	-	-	5.78E-04	3.49E-06	5.81E-04
Cadmium	-	-	-	-	-	1.82E-06	1.10E-08	1.83E-06
Copper	-	-	-	-	-	4.35E-04	2.63E-06	4.38E-04
Chromium	-	-	-	4.57 x 10 <sup>-5</sup>	2.67 x 10 <sup>-7</sup>	-	-	4.59 x 10 <sup>-5</sup>
Cyanide	-	-	-	-	-	4.23E-06	2.56E-06	6.79E-06
Selenium	-	-	-	-	-	5.54E-06	3.35E-08	5.57E-06
Zinc	-	-	-	-	-	9.50E-04	5.74E-06	9.56E-04
Benzene	4.17E-05	-	-	-	-	-	-	4.17E-05
Chlorobenzene	1.09E-05	-	-	-	-	-	-	1.09E-05
Chloroethane	6.67E-08	-	-	-	-	-	-	6.67E-08
Chloromethane	8.89E-07	-	-	-	-	-	-	8.89E-07
Dieldrin	-	-	-	-	-	7.91E-09	2.39E-09	1.03E-08
4,4'-DDT	-	-	-	-	-	2.18E-08	6.60E-09	2.84E-08
p-Dichlorobenzene	2.30E-06	-	-	-	-	-	-	2.30E-06
Dichlorodifluoromethane	1.85E-06	-	-	-	-	-	-	1.85E-06
cis-1,2-Dichloroethene	6.67E-07	-	-	-	-	-	-	6.67E-07
Ethylbenzene	4.35E-06	-	-	-	-	-	-	4.35E-06
Methylene Chloride	6.67E-08	-	-	-	-	-	-	6.67E-08
Tetrachloroethene	5.68E-07	1.19E-06	3.44E-06	-	-	-	-	5.20E-06
Toluene	6.67E-07	-	-	-	-	-	-	6.67E-07
Trichloroethene	6.91E-06	-	-	-	-	-	-	6.91E-06
Trichlorofluoromethane	1.68E-07	-	-	-	-	-	-	1.68E-07
Trimethylbenzene	1.14E-05	-	-	-	-	-	-	1.14E-05
Vinyl Chloride	3.21E-06	-	-	-	-	-	-	3.21E-06
Xylenes	1.17E-05	-	-	-	-	-	-	1.17E-05

**TABLE 3.13**  
**ADULT EXPOSURE DURATION AVERAGED DOSES**  
**CURRENT RECREATIONAL VISITOR**

<b>CHEMICALS</b>	<b>Landfill Gas mg/kg-day</b>	<b>Soil Ingestion mg/kg-day</b>	<b>Soil Absorption mg/kg-day</b>	<b>Total mg/kg-day</b>
Manganese	-	1.53E-04	1.44E-06	1.54E-04
Antimony	-	3.36E-06	3.17E-08	3.39E-06
Arsenic	-	3.66E-06	1.73E-06	5.39E-06
Barium	-	2.23E-04	2.10E-06	2.25E-04
Cadmium	-	7.02E-07	6.63E-09	7.09E-07
Copper	-	1.68E-04	1.59E-06	1.69E-04
Cyanide	-	1.63E-06	1.54E-06	3.18E-06
Selenium	-	2.14E-06	2.02E-08	2.16E-06
Zinc	-	3.66E-04	3.46E-06	3.70E-04
Benzene	2.15E-05	-	-	2.15E-05
Chlorobenzene	5.59E-06	-	-	5.59E-06
Chloroethane	3.43E-08	-	-	3.43E-08
Chloromethane	4.57E-07	-	-	4.57E-07
Dieldrin	-	3.05E-09	1.44E-09	4.49E-09
4,4'-DDT	-	8.43E-09	3.98E-09	1.24E-08
<i>p</i> -Dichlorobenzene	1.18E-06	-	-	1.18E-06
Dichlorodifluoromethane	9.52E-07	-	-	9.52E-07
<i>cis</i> -1,2-Dichloroethene	3.43E-07	-	-	3.43E-07
Ethylbenzene	2.24E-06	-	-	2.24E-06
Methylene Chloride	3.43E-08	-	-	3.43E-08
Tetrachloroethene	2.92E-07	-	-	2.92E-07
Toluene	3.43E-07	-	-	3.43E-07
Trichloroethene	3.56E-06	-	-	3.56E-06
Trichlorofluoromethane	8.64E-08	-	-	8.64E-08
Trimethylbenzene	5.84E-06	-	-	5.84E-06
Vinyl Chloride	1.65E-06	-	-	1.65E-06
Xylenes	5.99E-06	-	-	5.99E-06

TABLE 3.14  
LIFETIME AVERAGED EXPOSURE DOSES  
CURRENT RECREATIONAL VISITOR

CHEMICALS	Landfill Gas mg/kg-day	Surface Water Ingestion mg/kg-day	Surface Water Absorption mg/kg-day	Sediment Ingestion mg/kg-day	Sediment Absorption mg/kg-day	Soil Ingestion mg/kg-day	Soil Absorption mg/kg-day	Total mg/kg-day
Arsenic	-	-	-	$2.04 \times 10^{-7}$	$1.23 \times 10^{-9}$	1.57E-06	7.41E-07	$2.05 \times 10^{-7}$
2,3,7,8-TCDD Equivalents	-	7.12E-15	2.07E-14	-	-	5.29E-11	1.50E-11	6.78E-11
Benzo(a)pyrene Equivalents	-	-	-	-	-	9.63E-08	1.36E-07	0.00E+00
Benzene	9.20E-06	-	-	-	-	-	-	9.20E-06
Chloroethane	1.47E-08	-	-	-	-	-	-	1.47E-08
Chloromethane	1.96E-07	-	-	-	-	-	-	1.96E-07
4,4'-DDT	-	-	-	-	-	3.61E-09	1.70E-09	5.32E-09
4,4'-DDE	-	-	-	-	-	7.59E-10	3.58E-10	1.12E-09
Ethylbenzene	9.58E-07	-	-	-	-	-	-	9.58E-07
p-Dichlorobenzene	5.06E-07	-	-	-	-	-	-	5.06E-07
Methylene Chloride	1.47E-08	-	-	-	-	-	-	1.47E-08
Tetrachloroethene	1.25E-07	1.02E-07	2.95E-07	-	-	-	-	5.22E-07
Trichloroethene	1.52E-06	-	-	-	-	-	-	1.52E-06
Vinyl Chloride	7.08E-07	-	-	-	-	-	-	7.08E-07

**TABLE 3.15**  
**CHILD (AGE 1-6) EXPOSURE DURATION AVERAGED DOSES**  
**RECREATIONAL VISITOR**

<b>CHEMICALS</b>	<b>Inhalation of VOCs mg/kg-day</b>
Benzene	7.51E-05
Chlorobenzene	1.96E-05
Chloroethane	1.20E-07
Chloromethane	1.60E-06
<i>p</i> -Dichlorobenzene	4.13E-06
Dichlorodifluoromethane	3.33E-06
<i>cis</i> -1,2-Dichloroethene	1.20E-06
Ethylbenzene	7.82E-06
Methylene Chloride	1.20E-07
Tetrachloroethene	1.02E-06
Toluene	1.20E-06
Trichloroethene	1.24E-05
Trichlorofluoromethane	3.02E-07
Trimethylbenzene	2.04E-05
Vinyl Chloride	5.78E-06
Xylenes	2.10E-05

**TABLE 3.16**  
**CHILD (AGE 7-12) EXPOSURE DURATION AVERAGED DOSES**  
**FUTURE RECREATIONAL VISITOR**

CHEMICALS	Landfill Gas mg/kg-day	Surface Water Ingestion mg/kg-day	Surface Water Absorption mg/kg-day	Sediment Ingestion mg/kg-day	Sediment Absorption mg/kg-day	Total mg/kg-day
Manganese	-	9.50E-05	5.74E-05	-	-	1.52E-04
Arsenic	-	-	-	$2.37 \times 10^{-6}$	1.38E-11	$2.37 \times 10^{-6}$
Chromium	-	-	-	$4.57 \times 10^{-5}$	1.43E-09	$4.57 \times 10^{-5}$
Benzene	4.17E-05	-	-	-	-	4.17E-05
Chlorobenzene	1.09E-05	-	-	-	-	1.09E-05
Chloroethane	6.67E-08	-	-	-	-	6.67E-08
Chloromethane	8.89E-07	-	-	-	-	8.89E-07
<i>p</i> -Dichlorobenzene	2.30E-06	-	-	-	-	2.30E-06
Dichlorodifluoromethane	1.85E-06	-	-	-	-	1.85E-06
<i>cis</i> -1,2-Dichloroethene	6.67E-07	-	-	-	-	6.67E-07
Ethylbenzene	4.35E-06	-	-	-	-	4.35E-06
Methylene Chloride	6.67E-08	-	-	-	-	6.67E-08
Tetrachloroethene	5.68E-07	1.19E-06	3.44E-06	-	-	5.20E-06
Toluene	6.67E-07	-	-	-	-	6.67E-07
Trichloroethene	6.91E-06	-	-	-	-	6.91E-06
Trichlorofluoromethane	1.68E-07	-	-	-	-	1.68E-07
Trimethylbenzene	1.14E-05	-	-	-	-	1.14E-05
Vinyl Chloride	3.21E-06	-	-	-	-	3.21E-06
Xylenes	1.17E-05	-	-	-	-	1.17E-05

**TABLE 3.17**  
**ADULT EXPOSURE DURATION AVERAGED DOSES**  
**FUTURE RECREATIONAL VISITOR**

<b>CHEMICALS</b>	<b>Inhalation of VOCs mg/kg-day</b>
Benzene	2.15E-05
Chlorobenzene	5.59E-06
Chloroethane	3.43E-08
Chloromethane	4.57E-07
<i>p</i> -Dichlorobenzene	1.18E-06
Dichlorodifluoromethane	9.52E-07
<i>cis</i> -1,2-Dichloroethene	3.43E-07
Ethylbenzene	2.24E-06
Methylene Chloride	3.43E-08
Tetrachloroethene	2.92E-07
Toluene	3.43E-07
Trichloroethene	3.56E-06
Trichlorofluoromethane	8.64E-08
Trimethylbenzene	5.84E-06
Vinyl Chloride	1.65E-06
Xylenes	5.99E-06

**TABLE 3.18**  
**LIFETIME AVERAGED DOSES**  
**FUTURE RECREATIONAL VISITOR**

CHEMICALS	Landfill Gas mg/kg-day	Surface Water Ingestion mg/kg-day	Surface Water Absorption mg/kg-day	Sediment Ingestion mg/kg-day	Sediment Absorption mg/kg-day	Total mg/kg-day
Arsenic	-	-	-	$2.04 \times 10^{-7}$	$1.23 \times 10^{-9}$	$2.05 \times 10^{-7}$
2,3,7,8-TCDD Equivalents	-	7.12E-15	2.07E-14	-	-	2.78E-14
Benzene	9.20E-06	-	-	-	-	9.20E-06
Chloroethane	1.47E-08	-	-	-	-	1.47E-08
Chloromethane	1.96E-07	-	-	-	-	1.96E-07
Ethylbenzene	9.58E-07	-	-	-	-	9.58E-07
<i>p</i> -Dichlorobenzene	5.06E-07	-	-	-	-	5.06E-07
Methylene Chloride	1.47E-08	-	-	-	-	1.47E-08
Tetrachloroethene	1.25E-07	1.02E-07	2.95E-07	-	-	5.22E-07
Trichloroethene	1.52E-06	-	-	-	-	1.52E-06
Vinyl chloride	7.08E-07	-	-	-	-	7.08E-07

**TABLE 3.19**  
**CHILD (AGE 1-6) EXPOSURE DURATION AVERAGED DOSES**  
**FUTURE OFF-SITE RESIDENT**

CHEMICALS	Groundwater Ingestion mg/kg-day	Inhalation of VOCs mg/kg-day	Dermal Absorption mg/kg-day	Total mg/kg-day
Arsenic	3.20E-04	0.000E+00	9.67E-06	3.29E-04
Barium	3.32E-02	0.000E+00	3.35E-04	3.36E-02
Chromium	1.73E-03	0.000E+00	1.74E-05	1.74E-03
Iron	2.49E+00	0.000E+00	2.51E-02	2.52E+00
Manganese	3.39E-01	0.000E+00	3.42E-03	3.42E-01
Benzene	3.20E-03	6.106E-02	6.77E-05	6.43E-02
Chlorobenzene	1.09E-03	1.408E-02	4.49E-05	1.52E-02
Chloroform	1.15E-04	1.451E-03	1.03E-06	1.57E-03
1,3-Dichlorobenzene	5.11E-04	4.920E-03	4.48E-05	5.48E-03
1,4-Dichlorobenzene	5.75E-04	5.337E-03	3.60E-05	5.95E-03
1,1-Dichloroethene	4.67E-04	4.185E-02	7.53E-06	4.23E-02
<i>cis</i> -Dichloroethene	1.85E-02	2.146E-01	1.87E-04	2.33E-01
<i>trans</i> -Dichloroethene	1.73E-03	3.985E-02	1.74E-05	4.16E-02
Methylene chloride	3.20E-04	3.569E-03	1.45E-06	3.89E-03
Naphthalene	2.62E-03	4.349E-03	1.82E-04	7.15E-03
<i>n</i> -Propylbenzene	5.11E-04	1.845E-02	5.16E-07	1.90E-02
Tetrachloroethene	6.00E-02	3.646E+00	2.90E-03	3.71E+00
Trichloroethene	1.47E-02	5.051E-01	2.37E-04	5.20E-01
1,2,4-Trimethylbenzene	8.31E-04	1.759E-02	8.38E-05	1.85E-02
1,3,5-Trimethylbenzene	2.56E-04	7.704E-03	2.58E-05	7.99E-03
Vinyl Chloride	2.49E-03	4.797E-01	1.83E-05	4.82E-01
<i>o</i> -Xylene	3.20E-04	7.687E-03	2.58E-05	8.03E-03
<i>p</i> -Xylene	1.92E-04	4.612E-03	1.55E-05	4.82E-03

**TABLE 3.20**  
**CHILD (AGE 7-12) EXPOSURE DURATION AVERAGED DOSES**  
**FUTURE OFF-SITE RESIDENT**

CHEMICALS	Groundwater Ingestion mg/kg-day	Inhlation of VOCs mg/kg-day	Dermal Absorption mg/kg-day	Total mg/kg-day
Arsenic	3.55E-04	0.000E+00	7.83E-06	3.63E-04
Barium	3.69E-02	0.000E+00	2.71E-04	3.72E-02
Chromium	1.92E-03	0.000E+00	1.41E-05	1.93E-03
Iron	2.77E+00	0.000E+00	2.04E-02	2.79E+00
Manganese	3.76E-01	0.000E+00	2.77E-03	3.79E-01
Benzene	3.55E-03	3.392E-02	5.48E-05	3.75E-02
Chlorobenzene	1.21E-03	7.820E-03	3.64E-05	9.06E-03
Chloroform	1.28E-04	8.060E-04	8.36E-07	9.35E-04
1,3-Dichlorobenzene	5.68E-04	2.733E-03	3.63E-05	3.34E-03
1,4-Dichlorobenzene	6.39E-04	2.965E-03	2.91E-05	3.63E-03
1,1-Dichloroethene	5.19E-04	2.325E-02	6.10E-06	2.38E-02
<i>cis</i> -Dichloroethene	2.06E-02	1.192E-01	1.51E-04	1.40E-01
<i>trans</i> -Dichloroethene	1.92E-03	2.214E-02	1.41E-05	2.41E-02
Methylene chloride	3.55E-04	1.983E-03	1.17E-06	2.34E-03
Naphthalene	2.91E-03	2.416E-03	1.48E-04	5.48E-03
<i>n</i> -Propylbenzene	5.68E-04	1.025E-02	4.18E-07	1.08E-02
Tetrachloroethene	6.66E-02	2.026E+00	2.35E-03	2.09E+00
Trichloroethene	1.63E-02	2.806E-01	1.92E-04	2.97E-01
1,2,4-Trimethylbenzene	9.23E-04	9.771E-03	6.79E-05	1.08E-02
1,3,5-Trimethylbenzene	2.84E-04	4.280E-03	2.09E-05	4.59E-03
Vinyl Chloride	2.77E-03	2.665E-01	1.49E-05	2.69E-01
<i>o</i> -Xylene	3.55E-04	4.271E-03	2.09E-05	4.65E-03
<i>p</i> -Xylene	2.13E-04	2.562E-03	1.25E-05	2.79E-03

**TABLE 3.21**  
**ADULT EXPOSURE DURATION AVERAGED DOSES**  
**FUTURE OFF-SITE RESIDENT**

CHEMICALS	Groundwater Ingestion mg/kg-day	Inhalation of VOCs mg/kg-day	Dermal Absorption mg/kg-day	Total mg/kg-day
Arsenic	1.37E-04	0.000E+00	9.35E-06	1.46E-04
Barium	1.42E-02	0.000E+00	3.24E-04	1.46E-02
Chromium	7.40E-04	0.000E+00	1.68E-05	7.57E-04
Iron	1.07E+00	0.000E+00	2.43E-02	1.09E+00
Manganese	1.45E-01	0.000E+00	3.30E-03	1.49E-01
Benzene	1.37E-03	2.336E-02	6.54E-05	2.48E-02
Chlorobenzene	4.66E-04	5.386E-03	4.34E-05	5.90E-03
Chloroform	4.93E-05	5.552E-04	9.99E-07	6.05E-04
1,3-Dichlorobenzene	2.19E-04	1.883E-03	4.34E-05	2.15E-03
1,4-Dichlorobenzene	2.47E-04	2.042E-03	3.48E-05	2.32E-03
1,1-Dichloroethene	2.00E-04	1.601E-02	7.28E-06	1.62E-02
<i>cis</i> -Dichloroethene	7.95E-03	8.213E-02	1.81E-04	9.03E-02
<i>trans</i> -Dichloroethene	7.40E-04	1.525E-02	1.68E-05	1.60E-02
Methylene chloride	1.37E-04	1.366E-03	1.40E-06	1.50E-03
Naphthalene	1.12E-03	1.664E-03	1.76E-04	2.96E-03
<i>n</i> -Propylbenzene	2.19E-04	7.059E-03	4.99E-07	7.28E-03
Tetrachloroethene	2.57E-02	1.395E+00	2.81E-03	1.42E+00
Trichloroethene	6.30E-03	1.933E-01	2.29E-04	2.00E-01
1,2,4-Trimethylbenzene	3.56E-04	6.730E-03	8.10E-05	7.17E-03
1,3,5-Trimethylbenzene	1.10E-04	2.948E-03	2.49E-05	3.08E-03
Vinyl Chloride	1.07E-03	1.835E-01	1.77E-05	1.85E-01
<i>o</i> -Xylene	1.37E-04	2.941E-03	2.49E-05	3.10E-03
<i>p</i> -Xylene	8.22E-05	1.765E-03	1.50E-05	1.86E-03

**TABLE 3.22**  
**LIFETIME - AVERAGED DOSES**  
**FUTURE OFF SITE RESIDENT**

CHEMICALS	Groundwater Ingestion mg/kg-day	Inhlation of VOCs mg/kg-day	Dermal Absorption mg/kg-day	Total
Arsenic	5.87E-05	-	1.14E-08	5.87E-05
Benzene	5.87E-04	1.001E-02	8.01E-08	1.06E-02
Chloroform	2.11E-05	2.379E-04	1.22E-09	2.59E-04
1,4-Dichlorobenzene	1.06E-04	8.752E-04	4.26E-08	9.81E-04
1,1-Dichloroethene	8.57E-05	6.862E-03	8.91E-09	6.95E-03
Methylene chloride	5.87E-05	5.853E-04	1.72E-09	6.44E-04
Tetrachloroethene	1.10E-02	5.980E-01	1.20E-03	6.10E-01
Trichloroethene	2.70E-03	8.284E-02	2.81E-07	8.55E-02
Vinyl Chloride	4.58E-04	7.866E-02	2.17E-08	7.91E-02
2,3,7,8-TCDD Equivalents	8.69E-12	1.786E-13	1.69E-15	8.87E-12
alpha-BHC ( <i>a</i> -HCH)	2.00E-06	4.225E-09	6.49E-10	2.00E-06
beta-BHC ( <i>b</i> -HCH)	9.75E-06	1.166E-07	3.17E-09	9.87E-06
Arochlor 1242	1.70E-05	2.037E-07	5.53E-09	1.72E-05

**TABLE 5.7**  
**CHILD (AGE 1-6) HAZARD QUOTIENTS**  
**FUTURE OFF-SITE RESIDENT**

CHEMICALS	Hazard Quotient Ingestion	Hazard Quotient Inhalation	Hazard Quotient Adsorption	Total
Arsenic	1.07	0.00	3.22E-02	1.10
Barium	0.47	0.00	4.79E-03	0.48
Chromium	0.58	0.00	4.46E-01	1.02
Iron	8.31	0.00	8.38E-02	8.39
Manganese	14.12	0.00	3.56E+00	17.67
Benzene	1.07	35.92	2.26E-02	37.00
Chlorobenzene	0.05	0.70	2.25E-03	0.76
Chloroform	0.01	16.12	1.03E-04	16.13
1,3-Dichlorobenzene	0.06	0.55	4.98E-03	0.61
1,4-Dichlorobenzene	0.02	0.02	1.20E-03	0.04
1,1-Dichloroethene	0.05	4.65	8.36E-04	4.70
<i>cis</i> -Dichloroethene	1.85	21.46	1.87E-02	23.34
<i>trans</i> -Dichloroethene	0.09	1.99	8.70E-04	2.08
Methylene chloride	0.01	0.04	2.42E-05	0.05
Naphthalene	0.13	5.06	9.11E-03	5.20
<i>n</i> -Propylbenzene	0.05	1.84	5.16E-05	1.90
Tetrachloroethene	6.00	121.55	2.90E-01	127.83
Trichloroethene	2.45	89.09	3.95E-02	91.58
1,2,4-Trimethylbenzene	0.02	10.17	1.68E-03	10.18
1,3,5-Trimethylbenzene	0.01	4.45	5.16E-04	4.46
Vinyl Chloride	0.83	4.80	6.12E-03	5.63
<i>o</i> -Xylene	0.00	0.00	1.29E-05	0.00
<i>p</i> -Xylene	0.00	0.00	7.73E-06	0.00
<b>Total</b>				<b>360</b>

**TABLE 5.8**  
**CHILD (AGE 7-12) HAZARD QUOTIENTS**  
**FUTURE OFF-SITE RESIDENT**

CHEMICALS	Hazard Quotient Ingection	Hazard Quotient Inhalation	Hazard Quotient Adsorption	Total
Arsenic	1.18	0.00	2.61E-02	1.21
Barium	0.53	0.00	3.88E-03	0.53
Chromium	0.64	0.00	3.61E-01	1.00
Iron	9.23	0.00	6.79E-02	9.30
Manganese	15.69	0.00	2.88E+00	18.57
Benzene	1.18	19.95	1.83E-02	21.16
Chlorobenzene	0.06	0.39	1.82E-03	0.45
Chloroform	0.01	8.96	8.36E-05	8.97
1,3-Dichlorobenzene	0.06	0.30	4.04E-03	0.37
1,4-Dichlorobenzene	0.02	0.01	9.71E-04	0.04
1,1-Dichloroethene	0.06	2.58	6.78E-04	2.64
<i>cis</i> -Dichloroethene	2.06	11.92	1.51E-02	14.00
<i>trans</i> -Dichloroethene	0.10	1.11	7.05E-04	1.20
Methylene chloride	0.01	0.00	1.96E-05	0.01
Naphthalene	0.15	2.81	7.38E-03	2.96
<i>n</i> -Propylbenzene	0.06	1.02	4.18E-05	1.08
Tetrachloroethene	6.66	67.53	2.35E-01	74.42
Trichloroethene	2.72	49.49	3.20E-02	52.25
1,2,4-Trimethylbenzene	0.02	5.65	1.36E-03	5.67
1,3,5-Trimethylbenzene	0.01	2.47	4.18E-04	2.48
Vinyl Chloride	0.92	2.66	4.95E-03	3.59
<i>o</i> -Xylene	0.00	0.00	1.04E-05	0.00
<i>p</i> -Xylene	0.00	0.00	6.26E-06	0.00
<b>Total</b>				<b>222</b>

**TABLE 5.9**  
**ADULT HAZARD QUOTIENTS**  
**FUTURE OFF-SITE RESIDENT**

CHEMICALS	Hazard Quotient Ingestion	Hazard Quotient Inhalation	Hazard Quotient Adsorption	Total
Arsenic	0.46	0.00	3.12E-02	0.49
Barium	0.20	0.00	4.63E-03	0.21
Chromium	0.25	0.00	4.32E-01	0.68
Iron	3.56	0.00	8.10E-02	3.64
Manganese	6.05	0.00	3.44E+00	9.49
Benzene	0.46	13.74	2.18E-02	14.22
Chlorobenzene	0.02	0.27	2.17E-03	0.29
Chloroform	0.00	6.17	9.99E-05	6.17
1,3-Dichlorobenzene	0.02	0.21	4.82E-03	0.24
1,4-Dichlorobenzene	0.01	0.01	1.16E-03	0.02
1,1-Dichloroethene	0.02	1.78	8.09E-04	1.80
<i>cis</i> -Dichloroethene	0.79	8.21	1.81E-02	9.03
<i>trans</i> -Dichloroethene	0.04	0.76	8.41E-04	0.80
Methylene chloride	0.00	0.02	2.34E-05	0.02
Naphthalene	0.06	1.94	8.82E-03	2.00
<i>n</i> -Propylbenzene	0.02	0.71	4.99E-05	0.73
Tetrachloroethene	2.57	46.51	2.81E-01	49.36
Trichloroethene	1.05	34.09	3.82E-02	35.18
1,2,4-Trimethylbenzene	0.01	3.89	1.62E-03	3.90
1,3,5-Trimethylbenzene	0.00	1.70	4.99E-04	1.71
Vinyl Chloride	0.36	1.84	5.92E-03	2.20
<i>o</i> -Xylene	0.00	0.00	1.25E-05	0.00
<i>p</i> -Xylene	0.00	0.00	7.48E-06	0.00
<b>Total</b>				<b>142</b>

TABLE 5.10  
LIFETIME AVERAGED CARCINOGENIC RISK  
CURRENT RECREATIONAL VISITOR

CHEMICALS	Landfill Gas Risk	Surface Water Ingestion Risk	Surface Water Absorption Risk	Sediment Ingestion Risk	Sediment Absorption Risk	Soil Ingestion Risk	Soil Absorption Risk	Total Carcinogenic Risk
Arsenic	-	-	-	$3.05 \times 10^{-7}$	$1.84 \times 10^{-9}$	2.36E-06	1.12E-06	3.48E-06
2,3,7,8-TCDD Equivalents	-	1.07E-09	3.10E-09	-	-	7.93E-06	2.27E-06	1.02E-05
Benzo(a)pyrene Equivalents	-	-	-	-	-	7.08E-07	1.01E-06	1.72E-06
Benzene	2.51E-07	-	-	-	-	-	-	2.51E-07
Chloroethane	4.26E-11	-	-	-	-	-	-	4.26E-11
Chloromethane	1.23E-09	-	-	-	-	-	-	1.23E-09
4,4'-DDT	-	-	-	-	-	1.23E-09	1.23E-10	1.35E-09
4,4'-DDE	-	-	-	-	-	2.58E-10	1.12E-06	1.12E-06
Ethylbenzene	3.64E-09	-	-	-	-	-	-	3.64E-09
p-Dichlorobenzene	1.21E-08	-	-	-	-	-	-	1.21E-08
Methylene Chloride	2.35E-11	-	-	-	-	-	-	2.35E-11
Tetrachloroethene	2.50E-10	5.29E-09	1.53E-08	-	-	-	-	2.09E-08
Trichloroethene	9.14E-09	-	-	-	-	-	-	9.14E-09
Vinyl Chloride	2.19E-08	-	-	-	-	-	-	-
Total								1.68E-05

**TABLE 5.12**  
**LIFETIME CARCINOGENIC RISK - GROUNDWATER**  
**FUTURE OFF SITE RESIDENT**

CHEMICALS	Carcinogenic Risk Ingestion	Carcinogenic Risk Inhalation	Carcinogenic Risk Adsorption	Total
Arsenic	8.81E-05	0.000E+00	1.72E-08	8.81E-05
Benzene	3.23E-05	2.734E-04	4.41E-09	3.06E-04
Chloroform	1.29E-07	1.927E-05	7.46E-12	1.94E-05
1,4-Dichlorobenzene	2.54E-06	2.101E-05	1.02E-09	2.35E-05
1,1-Dichloroethene	5.14E-05	1.235E-03	5.35E-09	1.29E-03
Methylene chloride	4.40E-07	9.365E-07	1.29E-11	1.38E-06
Tetrachloroethene	5.73E-04	1.196E-03	6.25E-05	1.83E-03
Trichloroethene	2.97E-05	4.970E-04	3.09E-09	5.27E-04
Vinyl Chloride	6.87E-04	2.439E-03	3.26E-08	3.13E-03
2,3,7,8-TCDD Equivalents	1.30E-06	2.679E-08	2.54E-10	1.33E-06
alpha-BHC ( <i>a</i> -HCH)	1.26E-05	2.662E-08	4.09E-09	1.26E-05
beta-BHC ( <i>b</i> -HCH)	1.75E-05	2.099E-07	5.70E-09	1.78E-05
Arochlor 1242	1.70E-05	2.037E-07	8.30E-09	1.72E-05
<b>Total</b>				<b>7.26E-03</b>

# Carcinogenic Soil Risk - Arkwright Landfill, Spartanburg, South Carolina

Ingestion and Dermal Contact Current Recreational Use Lifetime																
C <sub>r</sub> =	1E-06	kg/mg		C <sub>s</sub>	Ingestion	Intake Dermal Abs	Total	SF <sub>o</sub> Slope Factor	ABS	Source	SF <sub>d</sub> Slope Factor	Injection	Absorption	Contact Risk		
S <sub>a</sub> =	4,720	cm²/day		MW	mg/kg	mg/kg day	mg/kg day	(kg day)/mg			(kg day)/mg	SF <sub>o</sub> *Oral Intake	SF <sub>o</sub> *Oral Intake + SF <sub>d</sub> *Dermal Abs	SF <sub>o</sub> *Oral Intake + SF <sub>d</sub> *Dermal Abs		
F <sub>adh</sub> =	0.2	mg/cm²	SOIL													
F <sub>exp</sub> =	78	days/year	2,3,7,8-TCDD Equivalents	322.0	0.00040	5.29E-11	1.50E-11	6.78E-11	1.5E+05	HEAST	>50%	RAGS (Pt E)	1.50E+05	7.93E-06	2.25E-06	1.017E-05
F <sub>con</sub> =	1.00	Surface Soil	Benzo(a)pyrene Equivalents	252.3	0.736	9.63E-08	1.36E-07	2.33E-07	7.4E+00	IRIS	>50%	RAGS (Pt E)	7.35E+00	7.08E-07	1.00E-06	1.710E-06
			4,4'-DDT	354.5	0.0276	3.61E-09	1.70E-09	5.32E-09	3.4E-01	IRIS	>50%	RAGS (Pt E)	3.40E-01	1.23E-09	5.80E-10	1.807E-09
D <sub>exp</sub> (NC) =	30	years	4,4'-DDE	318.0	0.0058	7.59E-10	3.58E-10	1.12E-09	3.4E-01	IRIS	>50%	ASTDR	3.40E-01	2.58E-10	1.22E-10	3.798E-10
W <sub>b</sub> =	70	kg	Arsenic	74.9	12.0	1.57E-06	7.41E-07	2.31E-06	1.5E+00	IRIS	>50%	RAGS (Pt E)	1.50E+00	2.36E-06	1.11E-06	3.467E-06
T <sub>avg</sub> =	10,950	days (NC)														
ABS																
Chl Pest	0.05															1.5E-05
PNA	0.15															
CDD&CDD	0.03															
Org chem	0.15															
Free CN	0.10															
As	0.05															
Cd	0.00															
Cr	0.00															
Metals	0.001															

# Noncarcinogenic Risk for Groundwater Exposure - Arkwright Landfill, Sparta

Child (1-6)  
Future Off-Site Resident

	MW	5,300		Ingestion		Hazard Quotient	Hazard HSDB		Inhalation		H
		C <sub>w</sub> μg/L	C <sub>w</sub> mg/L	Intake mg/kg day	Ref. Dose mg/(kg day)		H x (10 <sup>3</sup> ) M <sup>3</sup> -atm/mol	C <sub>a</sub> mg/M <sup>3</sup>	Intake mg/kg day	Ref. Dose mg/(kg day)	
GROUNDWATER											
day Arsenic	74.9	5.0	0.0050	3.20E-04	3.00E-04	1.065	0.00	0.00	0.000E+00	3.00E-04	C
Barium	137.3	520	0.5200	3.32E-02	7.00E-02	0.475	0.00	0.00	0.000E+00	7.00E-02	C
Chromium	52.0	27	0.0270	1.73E-03	3.00E-03	0.575	0.00	0.00	0.000E+00	3.00E-03	C
Iron	55.8	39,000	39.0000	2.49E+00	3.00E-01	8.311	0.00	0.00	0.000E+00	3.00E-01	C
ar Manganese	54.9	5,300	5.3000	3.39E-01	2.40E-02	14.117	0.00	0.00	0.000E+00	2.40E-02	C
Benzene	78.1	50.00	0.0500	3.20E-03	3.00E-03	1.065	5.56	11.37	6.106E-02	1.70E-03	3
Chlorobenzene	112.6	17	0.0170	1.09E-03	0.02	0.054	3.77	2.62	1.408E-02	2.00E-02	C
sin) Chloroform	119.4	1.80	0.0018	1.15E-04	1.0E-02	0.012	3.67	0.27	1.451E-03	9.00E-05	1
1,3-Dichlorobenzene	147.0	8.00	0.0080	5.11E-04	9.0E-03	0.057	2.80	0.92	4.920E-03	9.00E-03	C
1,4-Dichlorobenzene	147.0	9.0	0.0090	5.75E-04	3.0E-02	0.019	2.70	0.99	5.337E-03	2.30E-01	C
1,1-Dichloroethene	96.9	7.30	0.0073	4.67E-04	9.0E-03	0.052	26.10	7.79	4.185E-02	9.00E-03	4
cis-Dichloroethene	96.9	290.00	0.2900	1.85E-02	1.0E-02	1.854	3.37	39.97	2.146E-01	1.00E-02	2
trans-Dichloroethene	96.9	27.00	0.0270	1.73E-03	2.0E-02	0.086	6.72	7.42	3.985E-02	2.00E-02	1
Methylene chloride	84.9	5.0	0.0050	3.20E-04	6.0E-02	0.005	3.25	0.66	3.569E-03	8.60E-02	C
Naphthalene	128.2	41.0	0.0410	2.62E-03	2.0E-02	0.131	0.48	0.81	4.349E-03	8.60E-04	5
n-Propylbenzene	120.2	8.0	0.0080	5.11E-04	1.0E-02	0.051	10.50	3.44	1.845E-02	1.00E-02	1
Tetrachloroethene	165.8	938	0.9380	6.00E-02	1.0E-02	5.996	17.70	679.04	3.646E+00	3.00E-02	12
Trichloroethene	131.4	230	0.2300	1.47E-02	6.0E-03	2.451	10.00	94.07	5.051E-01	5.67E-03	8
1,2,4-Trimethylbenzene	120.2	13	0.0130	8.31E-04	5.0E-02	0.017	6.16	3.28	1.759E-02	1.73E-03	1
1,3,5-Trimethylbenzene	120.2	4	0.0040	2.56E-04	5.0E-02	0.005	8.77	1.43	7.704E-03	1.73E-03	4
Vinyl Chloride	62.5	39	0.0390	2.49E-03	3.0E-03	0.831	56.00	89.33	4.797E-01	1.00E-01	4
o-Xylene	106.2	5	0.0050	3.20E-04	2.0E+00	0.000	7.00	1.43	7.687E-03	2.00E+00	C
p-Xylene	106.2	3	0.0030	1.92E-04	2.0E+00	0.000	7.00	0.86	4.612E-03	2.00E+00	C

# er Exposure - Arkwright Landfill, Spartanburg, South Carolina

Child (1-6)  
Future Off-Site Resident

Hazard Quotient Intake/ ke/R <sub>f</sub> D <sub>0</sub>	Hazard HSDB		Intake mg/kg day	Inhalation RfD <sub>i</sub>		Hazard Quotient Intake/R <sub>f</sub> D <sub>i</sub>	Kp cm/hr	Intake mg/kg day	Absorption RfD <sub>a</sub>		Hazard Quotient Intake/R <sub>f</sub> D <sub>0</sub>	Total Hazard Quotient	
	H x (10 <sup>3</sup> ) M <sup>3</sup> -atm/mol	C <sub>a</sub> mg/M <sup>3</sup>		Ref. Dose mg/(kg day)	ABS				Ref. Dose mg/(kg day)	Quotient		Hazard Quotient	
0.065	0.00	0.00	0.000E+00	3.00E-04	0.000	3.00E-02	9.67E-06	1.0	3.00E-04	3.22E-02	1.098	0.3	
0.475	0.00	0.00	0.000E+00	7.00E-02	0.000	0.01	3.35E-04	0.07	4.90E-03	6.84E-02	0.543	0.1	
0.575	0.00	0.00	0.000E+00	3.00E-03	0.000	0.01	1.74E-05	0.025	7.50E-05	2.32E-01	0.807	0.2	
0.311	0.00	0.00	0.000E+00	3.00E-01	0.000	0.01	2.51E-02	1.0	3.00E-01	8.38E-02	8.394	2.3	
4.117	0.00	0.00	0.000E+00	2.40E-02	0.000	0.01	3.42E-03	0.040	9.60E-04	3.56E+00	17.675	4.9	
0.065	5.56	11.37	6.106E-02	1.70E-03	35.915	2.10E-02	6.77E-05	1.0	3.00E-03	2.26E-02	37.003	10.1	
0.054	3.77	2.62	1.408E-02	2.00E-02	0.704	4.10E-02	4.49E-05	1.0	2.00E-02	2.25E-03	0.760	0.2	
0.012	3.67	0.27	1.451E-03	9.00E-05	16.121	8.90E-03	1.03E-06	1.0	1.00E-02	1.03E-04	16.132	4.4	
0.057	2.80	0.92	4.920E-03	9.00E-03	0.547	8.70E-02	4.48E-05	1.0	9.00E-03	4.98E-03	0.608	0.1	
0.019	2.70	0.99	5.337E-03	2.30E-01	0.023	6.20E-02	3.60E-05	1.0	3.00E-02	1.20E-03	0.044	0.0	
0.052	26.10	7.79	4.185E-02	9.00E-03	4.649	1.60E-02	7.53E-06	1.0	9.00E-03	8.36E-04	4.702	1.3	
0.854	3.37	39.97	2.146E-01	1.00E-02	21.464	1.00E-02	1.87E-04	1.0	1.00E-02	1.87E-02	23.337	6.4	
0.086	6.72	7.42	3.985E-02	2.00E-02	1.992	1.00E-02	1.74E-05	1.0	2.00E-02	8.70E-04	2.080	0.5	
0.005	3.25	0.66	3.569E-03	8.60E-02	0.041	4.50E-03	1.45E-06	1.0	6.00E-02	2.42E-05	0.047	0.0	
0.131	0.48	0.81	4.349E-03	8.60E-04	5.057	6.90E-02	1.82E-04	1.0	2.00E-02	9.11E-03	5.197	1.4	
0.051	10.50	3.44	1.845E-02	1.00E-02	1.845	1.00E-03	5.16E-07	1.0	1.00E-02	5.16E-05	1.896	0.5	
0.996	17.70	679.04	3.646E+00	3.00E-02	121.546	4.80E-02	2.90E-03	1.0	1.00E-02	2.90E-01	127.832	35.1	
0.451	10.00	94.07	5.051E-01	5.67E-03	89.090	1.60E-02	2.37E-04	1.0	6.00E-03	3.95E-02	91.580	25.4	
0.017	6.16	3.28	1.759E-02	1.73E-03	10.166	1.00E-01	8.38E-05	1.0	5.00E-02	1.68E-03	10.185	2.8	
0.005	8.77	1.43	7.704E-03	1.73E-03	4.453	1.00E-01	2.58E-05	1.0	5.00E-02	5.16E-04	4.459	1.2	
0.831	56.00	89.33	4.797E-01	1.00E-01	4.797	7.30E-03	1.83E-05	1.0	3.00E-03	6.12E-03	5.634	1.5	
0.000	7.00	1.43	7.687E-03	2.00E+00	0.004	8.00E-02	2.58E-05	1.0	2.00E+00	1.29E-05	0.004	0.0	
0.000	7.00	0.86	4.612E-03	2.00E+00	0.002	8.00E-02	1.55E-05	1.0	2.00E+00	7.73E-06	0.002	0.0	
Hazard Index												360.02	

# Noncarcinogenic Risk for Groundwater Exposure - Arkwright Landfill, Spartanburg

## Child (7-12) Noncarcinogenic Effects Future Off-Site Resident

		Ingestion					Hazard			Inhalation		
					RfD <sub>o</sub>	Hazard	Hazard			RfD <sub>i</sub>	H <sub>i</sub>	
		C <sub>w</sub>	C <sub>w</sub>	Intake	Ref. Dose	Quotient	H x (10 <sup>3</sup> )	C <sub>i</sub>	Intake	Ref. Dose	Qu	
		MW	µg/L	mg/kg day	mg/(kg day)	Intake/R <sub>o</sub> D <sub>o</sub>	M <sup>3</sup> -atm/mol	mg/M <sup>3</sup>	mg/kg day	mg/(kg day)	Intal	
GROUNDWATER												
day	Arsenic	74.9	5.0	0.0050	3.55E-04	3.00E-04	1.184	0.00	0.00	0.000E+00	0.000	0.00
	Barium	137.3	520	0.5200	3.69E-02	7.00E-02	0.528	0.00	0.00	0.000E+00	0.070	0.00
	Chromium	52.0	27	0.0270	1.92E-03	3.00E-03	0.639	0.00	0.00	0.000E+00	0.003	0.00
ir	Iron	55.8	39,000	39.0000	2.77E+00	3.00E-01	9.234	0.00	0.00	0.000E+00	0.300	0.00
	Manganese	54.9	5,300	5.3000	3.76E-01	2.40E-02	15.686	0.00	0.00	0.000E+00	0.024	0.00
	Benzene	78.1	50.00	0.0500	3.55E-03	3.00E-03	1.184	5.56	11.37	3.392E-02	1.70E-03	2.00
in)	Chlorobenzene	112.6	17	0.0170	1.21E-03	0.02	0.060	3.77	7.820E-03	0.020	3.9	
	Chloroform	119.4	1.80	0.0018	1.28E-04	1.0E-02	0.013	3.67	8.060E-04	9.00E-05	8.90	
	1,3-Dichlorobenzene	147.0	8.00	0.0080	5.68E-04	9.0E-03	0.063	2.80	0.92	2.733E-03	0.009	3.00
	1,4-Dichlorobenzene	147.0	9.0	0.0090	6.39E-04	3.0E-02	0.021	2.70	0.99	2.965E-03	0.230	1.20
	1,1-Dichloroethene	96.9	7.30	0.0073	5.19E-04	9.0E-03	0.058	26.10	7.79	2.325E-02	0.009	2.50
	cis-Dichloroethene	96.9	290.00	0.2900	2.06E-02	1.0E-02	2.060	3.37	39.97	1.192E-01	0.010	1.10
	trans-Dichloroethene	96.9	27.00	0.0270	1.92E-03	2.0E-02	0.096	6.72	7.42	2.214E-02	0.020	1.10
	Methylene chloride	84.9	5.0	0.0050	3.55E-04	6.0E-02	0.006	3.25	0.66	1.983E-03	0.860	2.30
	Naphthalene	128.2	41.0	0.0410	2.91E-03	2.0E-02	0.146	0.48	0.81	2.416E-03	0.001	2.81
	n-Propylbenzene	120.2	8.0	0.0080	5.68E-04	1.0E-02	0.057	10.50	3.44	1.025E-02	0.010	1.02
	Tetrachloroethene	165.8	938	0.9380	6.66E-02	1.0E-02	6.663	17.70	679.04	2.026E+00	0.030	6.75
	Trichloroethene	131.4	230	0.2300	1.63E-02	6.0E-03	2.723	10.00	94.07	2.806E-01	0.006	4.95
	1,2,4-Trimethylbenzene	120.2	13	0.0130	9.23E-04	5.0E-02	0.018	6.16	3.28	9.771E-03	0.002	5.65
	1,3,5-Trimethylbenzene	120.2	4	0.0040	2.84E-04	5.0E-02	0.006	8.77	1.43	4.280E-03	0.002	2.47
	Vinyl Chloride	62.5	39	0.0390	2.77E-03	3.0E-03	0.923	56.00	89.33	2.665E-01	0.100	2.66
o-Xylene	106.2	5	0.0050	3.55E-04	2.0E+00	0.000	7.00	1.43	4.271E-03	2.000	2.14	
p-Xylene	106.2	3	0.0030	2.13E-04	2.0E+00	0.000	7.00	0.86	2.562E-03	2.000	1.25	

## re - Arkwright Landfill, Spartanburg, South Carolina

;) Noncarcinogenic Effects  
re Off-Site Resident

Hazard HSDB H x (10 <sup>3</sup> ) M <sup>3</sup> -atm/mol	C <sub>a</sub> mg/M <sup>3</sup>	Intake mg/kg day	Inhalation RfD <sub>i</sub> Ref. Dose mg/(kg day)	Hazard Quotient Intake/RfD <sub>i</sub>	Kp cm/hr	Intake mg/kg day	Abs mg/(kg day)	Absorption RfD <sub>a</sub> Ref. Dose mg/(kg day)	Hazard Quotient Intake/RfD <sub>a</sub>	Total Hazard Quotient	% of Risk
0.00	0.00	0.000E+00	0.000	0.00E+00	3.00E-02	7.83E-06	1.0	3.00E-04	2.61E-02	1.210	0.55%
0.00	0.00	0.000E+00	0.070	0.00E+00	0.01	2.71E-04	0.07	4.90E-03	5.54E-02	0.583	0.26%
0.00	0.00	0.000E+00	0.003	0.00E+00	0.01	1.41E-05	0.025	7.50E-05	1.88E-01	0.827	0.37%
0.00	0.00	0.000E+00	0.300	0.00E+00	0.01	2.04E-02	1.0	3.00E-01	6.79E-02	9.302	4.19%
0.00	0.00	0.000E+00	0.024	0.00E+00	0.01	2.77E-03	0.04	9.60E-04	2.88E+00	18.568	8.37%
5.56	11.37	3.392E-02	1.70E-03	2.00E+01	2.10E-02	5.48E-05	1.0	3.00E-03	1.83E-02	21.155	9.54%
3.77	2.62	7.820E-03	0.020	3.91E-01	4.10E-02	3.64E-05	1.0	2.00E-02	1.82E-03	0.453	0.20%
3.67	0.27	8.060E-04	9.00E-05	8.96E+00	8.90E-03	8.36E-07	1.0	1.00E-02	8.36E-05	8.969	4.04%
2.80	0.92	2.733E-03	0.009	3.04E-01	8.70E-02	3.63E-05	1.0	9.00E-03	4.04E-03	0.371	0.17%
2.70	0.99	2.965E-03	0.230	1.29E-02	6.20E-02	2.91E-05	1.0	3.00E-02	9.71E-04	0.035	0.02%
26.10	7.79	2.325E-02	0.009	2.58E+00	1.60E-02	6.10E-06	1.0	9.00E-03	6.78E-04	2.641	1.19%
3.37	39.97	1.192E-01	0.010	1.19E+01	1.00E-02	1.51E-04	1.0	1.00E-02	1.51E-02	13.999	6.31%
6.72	7.42	2.214E-02	0.020	1.11E+00	1.00E-02	1.41E-05	1.0	2.00E-02	7.05E-04	1.204	0.54%
3.25	0.66	1.983E-03	0.860	2.31E-03	4.50E-03	1.17E-06	1.0	6.00E-02	1.96E-05	0.008	0.00%
0.48	0.81	2.416E-03	0.001	2.81E+00	6.90E-02	1.48E-04	1.0	2.00E-02	7.38E-03	2.963	1.34%
10.50	3.44	1.025E-02	0.010	1.02E+00	1.00E-03	4.18E-07	1.0	1.00E-02	4.18E-05	1.082	0.49%
17.70	679.04	2.026E+00	0.030	6.75E+01	4.80E-02	2.35E-03	1.0	1.00E-02	2.35E-01	74.423	33.56%
10.00	94.07	2.806E-01	0.006	4.95E+01	1.60E-02	1.92E-04	1.0	6.00E-03	3.20E-02	52.249	23.56%
6.16	3.28	9.771E-03	0.002	5.65E+00	1.00E-01	6.79E-05	1.0	5.00E-02	1.36E-03	5.668	2.56%
8.77	1.43	4.280E-03	0.002	2.47E+00	1.00E-01	2.09E-05	1.0	5.00E-02	4.18E-04	2.480	1.12%
56.00	89.33	2.665E-01	0.100	2.66E+00	7.30E-03	1.49E-05	1.0	3.00E-03	4.95E-03	3.593	1.62%
7.00	1.43	4.271E-03	2.000	2.14E-03	8.00E-02	2.09E-05	1.0	2.00E+00	1.04E-05	0.002	0.00%
7.00	0.86	2.562E-03	2.000	1.28E-03	8.00E-02	1.25E-05	1.0	2.00E+00	6.26E-06	0.001	0.00%

Hazard Index 221.79

# Noncarcinogenic Risk for Groundwater Exposure - Arkwright Landfill, Spart

## Adult Noncarcinogenic Effects Future Off-Site Resident

		Ingestion					Hazard		Hazard		Inhalati	
			C <sub>w</sub>	C <sub>w</sub>	Intake	Ref. Dose	Quotient	H x (10 <sup>3</sup> )	C <sub>a</sub>	Intake	Ref. Dos	
		MW	µg/L	mg/L	mg/kg day	mg/(kg day)	Intake/R <sub>f</sub> D <sub>o</sub>	M <sup>3</sup> -atm/mol	mg/M <sup>3</sup>	mg/kg day	mg/(kg da	
GROUNDWATER												
L/day	Arsenic	74.9	5.0	0.0050	1.37E-04	3.00E-04	0.457	0.00	0.00	0.000E+00	3.00E-04	
M <sup>3</sup> of air/day	Barium	137.3	520	0.5200	1.42E-02	7.00E-02	0.204	0.00	0.00	0.000E+00	7.00E-02	
hr/day	Chromium	52.0	27	0.0270	7.40E-04	3.00E-03	0.247	0.00	0.00	0.000E+00	3.00E-03	
10 cm <sup>2</sup>	Iron	55.8	39,000	39.0000	1.07E+00	3.00E-01	3.562	0.00	0.00	0.000E+00	3.00E-01	
days/year	Manganese	54.9	5,300	5.3000	1.45E-01	2.40E-02	6.050	0.00	0.00	0.000E+00	2.40E-02	
years	Benzene	78.1	50.00	0.0500	1.37E-03	3.00E-03	0.457	5.56	11.37	2.336E-02	1.70E-03	
kg	Chlorobenzene	112.6	17	0.0170	4.66E-04	0.02	0.023	3.77	2.62	5.386E-03	2.00E-03	
10 days (carcin)	Chloroform	119.4	1.80	0.0018	4.93E-05	1.0E-02	0.005	3.67	0.27	5.552E-04	9.00E-03	
	1,3-Dichlorobenzene	147.0	8.00	0.0080	2.19E-04	9.0E-03	0.024	2.80	0.92	1.883E-03	9.00E-03	
	1,4-Dichlorobenzene	147.0	9.0	0.0090	2.47E-04	3.0E-02	0.008	2.70	0.99	2.042E-03	2.30E-03	
	1,1-Dichloroethene	96.9	7.30	0.0073	2.00E-04	9.0E-03	0.022	26.10	7.79	1.601E-02	9.00E-03	
	cis-Dichloroethene	96.9	290.00	0.2900	7.95E-03	1.0E-02	0.795	3.37	39.97	8.213E-02	1.00E-02	
	trans-Dichloroethene	96.9	27.00	0.0270	7.40E-04	2.0E-02	0.037	6.72	7.42	1.525E-02	2.00E-02	
	Methylene chloride	84.9	5.0	0.0050	1.37E-04	6.0E-02	0.002	3.25	0.66	1.366E-03	8.60E-03	
	Naphthalene	128.2	41.0	0.0410	1.12E-03	2.0E-02	0.056	0.48	0.81	1.664E-03	8.60E-04	
	n-Propylbenzene	120.2	8.0	0.0080	2.19E-04	1.0E-02	0.022	10.50	3.44	7.059E-03	1.00E-02	
	Tetrachloroethene	165.8	938	0.9380	2.57E-02	1.0E-02	2.570	17.70	679.04	1.395E+00	3.00E-02	
	Trichloroethene	131.4	230	0.2300	6.30E-03	6.0E-03	1.050	10.00	94.07	1.933E-01	5.67E-03	
	1,2,4-Trimethylbenzene	120.2	13	0.0130	3.56E-04	5.0E-02	0.007	6.16	3.28	6.730E-03	1.73E-03	
	1,3,5-Trimethylbenzene	120.2	4	0.0040	1.10E-04	5.0E-02	0.002	8.77	1.43	2.948E-03	1.73E-03	
	Vinyl Chloride	62.5	39	0.0390	1.07E-03	3.0E-03	0.356	56.00	89.33	1.835E-01	1.00E-01	
	o-Xylene	106.2	5	0.0050	1.37E-04	2.0E+00	0.000	7.00	1.43	2.941E-03	2.00E+00	
	p-Xylene	106.2	3	0.0030	8.22E-05	2.0E+00	0.000	7.00	0.86	1.765E-03	2.00E+00	

# er Exposure - Arkwright Landfill, Spartanburg, South Carolina

## Adult Noncarcinogenic Effects Future Off-Site Resident

1	Hazard				Inhalation			Absorption			Total		
	Hazard	HSDB			RfDi	Hazard				RfDa	Hazard	Total	
	Quotient	H x (10 <sup>3</sup> )	C <sub>a</sub>	Intake	Ref. Dose	Quotient	Kp	Intake	ABS	Ref. Dose	Quotient	Hazard	% c
	Intake/RfD <sub>o</sub>	M <sup>3</sup> -atm/mol	mg/M <sup>3</sup>	mg/kg day	mg/(kg day)	Intake/RfD <sub>o</sub>	cm/hr	mg/kg day	ABS	mg/(kg day)	Intake/RfD <sub>o</sub>	Quotient	Risk
	0.457	0.00	0.00	0.000E+00	3.00E-04	0.000	3.00E-02	9.35E-06	1.0	3.00E-04	3.12E-02	0.488	0.34
	0.204	0.00	0.00	0.000E+00	7.00E-02	0.000	0.01	3.24E-04	0.07	4.90E-03	6.61E-02	0.270	0.15
	0.247	0.00	0.00	0.000E+00	3.00E-03	0.000	0.01	1.68E-05	0.025	7.50E-05	2.24E-01	0.471	0.33
	3.562	0.00	0.00	0.000E+00	3.00E-01	0.000	0.01	2.43E-02	1.0	3.00E-01	8.10E-02	3.643	2.56
	6.050	0.00	0.00	0.000E+00	2.40E-02	0.000	0.01	3.30E-03	0.04	9.60E-04	3.44E+00	9.491	6.68
	0.457	5.56	11.37	2.336E-02	1.70E-03	13.743	2.10E-02	6.54E-05	1.0	3.00E-03	2.18E-02	14.222	10.0
	0.023	3.77	2.62	5.386E-03	2.00E-02	0.269	4.10E-02	4.34E-05	1.0	2.00E-02	2.17E-03	0.295	0.21
	0.005	3.67	0.27	5.552E-04	9.00E-05	6.169	8.90E-03	9.99E-07	1.0	1.00E-02	9.99E-05	6.174	4.35
	0.024	2.80	0.92	1.883E-03	9.00E-03	0.209	8.70E-02	4.34E-05	1.0	9.00E-03	4.82E-03	0.238	0.17
	0.008	2.70	0.99	2.042E-03	2.30E-01	0.009	6.20E-02	3.48E-05	1.0	3.00E-02	1.16E-03	0.018	0.01
	0.022	26.10	7.79	1.601E-02	9.00E-03	1.779	1.60E-02	7.28E-06	1.0	9.00E-03	8.09E-04	1.802	1.27
	0.795	3.37	39.97	8.213E-02	1.00E-02	8.213	1.00E-02	1.81E-04	1.0	1.00E-02	1.81E-02	9.026	6.35
	0.037	6.72	7.42	1.525E-02	2.00E-02	0.762	1.00E-02	1.68E-05	1.0	2.00E-02	8.41E-04	0.800	0.56
	0.002	3.25	0.66	1.366E-03	8.60E-02	0.016	4.50E-03	1.40E-06	1.0	6.00E-02	2.34E-05	0.018	0.01
	0.056	0.48	0.81	1.664E-03	8.60E-04	1.935	6.90E-02	1.76E-04	1.0	2.00E-02	8.82E-03	2.000	1.41
	0.022	10.50	3.44	7.059E-03	1.00E-02	0.706	1.00E-03	4.99E-07	1.0	1.00E-02	4.99E-05	0.728	0.51
	2.570	17.70	679.04	1.395E+00	3.00E-02	46.510	4.80E-02	2.81E-03	1.0	1.00E-02	2.81E-01	49.360	34.7
	1.050	10.00	94.07	1.933E-01	5.67E-03	34.091	1.60E-02	2.29E-04	1.0	6.00E-03	3.82E-02	35.179	24.7
	0.007	6.16	3.28	6.730E-03	1.73E-03	3.890	1.00E-01	8.10E-05	1.0	5.00E-02	1.62E-03	3.899	2.75
	0.002	8.77	1.43	2.948E-03	1.73E-03	1.704	1.00E-01	2.49E-05	1.0	5.00E-02	4.99E-04	1.707	1.20
	0.356	56.00	89.33	1.835E-01	1.00E-01	1.835	7.30E-03	1.77E-05	1.0	3.00E-03	5.92E-03	2.198	1.55
	0.000	7.00	1.43	2.941E-03	2.00E+00	0.001	8.00E-02	2.49E-05	1.0	2.00E+00	1.25E-05	0.002	0.00
	0.000	7.00	0.86	1.765E-03	2.00E+00	0.001	8.00E-02	1.50E-05	1.0	2.00E+00	7.48E-06	0.001	0.00

Hazard Index 142.03

## Carcinogenic for Groundwater Exposure - Arkwright Landfill, Spartanburg, South

Lifetime Future Off Site Resident								
					Ingestion SF <sub>o</sub>		HSDB	Inhalation
	MW	C <sub>w</sub> μg/L	C <sub>w</sub> mg/L	Intake mg/kg day	Slope Factor (kg day)/mg	Risk SF <sub>o</sub> * Intake	H x (10 <sup>3</sup> ) M <sup>3</sup> -atm/mol	Risk SF <sub>o</sub> * Intak
GROUNDWATER								
Arsenic	74.9	5.0	0.0050	5.87E-05	1.5E+00	8.806E-05		
Benzene	78.1	50.00	0.0500	5.87E-04	5.5E-02	3.229E-05	5.56	2.73E-04
Chloroform	119.4	1.80	0.0018	2.11E-05	6.1E-03	1.289E-07	3.67	1.93E-05
1,4-Dichlorobenzene	147.0	9.0	0.0090	1.06E-04	2.4E-02	2.536E-06	2.70	2.10E-05
1,1-Dichloroethene	96.9	7.30	0.0073	8.57E-05	6.0E-01	5.143E-05	26.10	1.24E-03
Methylene chloride	84.9	5.0	0.0050	5.87E-05	7.5E-03	4.403E-07	3.25	9.36E-07
Tetrachloroethene	165.8	938	0.9380	1.10E-02	5.2E-02	5.727E-04	17.70	1.20E-03
Trichloroethene	131.4	230	0.2300	2.70E-03	1.1E-02	2.971E-05	10.00	4.97E-04
Vinyl Chloride	62.5	39	0.0390	4.58E-04	1.5E+00	6.869E-04	56.00	2.44E-03
2,3,7,8-TCDD Equivalents	390.9	7.40E-07	7.40E-10	8.69E-12	1.5E+05	1.303E-06	6.700E-03	2.68E-08
alpha-BHC (α-HCH)	290.8	0.17	0.0002	2.00E-06	6.3E+00	1.258E-05	6.900E-04	2.66E-08
beta-BHC (β-HCH)	290.8	0.83	0.0008	9.75E-06	1.8E+00	1.754E-05	3.900E-03	2.10E-07
Arochlor 1242	261.0	1.45	0.0015	1.70E-05	4.0E-01	6.810E-06	3.900E-03	8.15E-08

losure - Arkwright Landfill, Spartanburg, South Carolina

Lifetime  
Future Off Site Resident

ay	Ingestion SF <sub>o</sub>		HSDB H x (10 <sup>3</sup> ) M <sup>3</sup> -atm/mol	Inhalation		Intake mg/kg day	Absorption SF <sub>d</sub>		Total Risk
	Slope Factor (kg day)/mg	Risk SF <sub>o</sub> * Intake		Risk SF <sub>o</sub> * Intake	Kp cm/hr		Slope Factor (kg day)/mg	Risk SF <sub>o</sub> * Intake	
5	1.5E+00	8.806E-05			3.00E-02	1.14E-08	1.50E+00	1.72E-08	8.81E-05
4	5.5E-02	3.229E-05	5.56	2.73E-04	2.10E-02	8.01E-08	5.50E-02	4.41E-09	3.06E-04
5	6.1E-03	1.289E-07	3.67	1.93E-05	8.90E-03	1.22E-09	6.10E-03	7.46E-12	1.94E-05
4	2.4E-02	2.536E-06	2.70	2.10E-05	6.20E-02	4.26E-08	2.40E-02	1.02E-09	2.35E-05
5	6.0E-01	5.143E-05	26.10	1.24E-03	1.60E-02	8.91E-09	6.00E-01	5.35E-09	1.29E-03
5	7.5E-03	4.403E-07	3.25	9.36E-07	4.50E-03	1.72E-09	7.50E-03	1.29E-11	1.38E-06
2	5.2E-02	5.727E-04	17.70	1.20E-03	4.80E-02	1.20E-03	5.20E-02	6.25E-05	1.83E-03
3	1.1E-02	2.971E-05	10.00	4.97E-04	1.60E-02	2.81E-07	1.10E-02	3.09E-09	5.27E-04
4	1.5E+00	6.869E-04	56.00	2.44E-03	7.30E-03	2.17E-08	1.50E+00	3.26E-08	3.13E-03
2	1.5E+05	1.303E-06	6.700E-03	2.68E-08	3.00E-02	1.69E-15	1.50E+05	2.54E-10	1.33E-06
6	6.3E+00	1.258E-05	6.900E-04	2.66E-08	5.00E-02	6.49E-10	6.30E+00	4.09E-09	1.26E-05
6	1.8E+00	1.754E-05	3.900E-03	2.10E-07	5.00E-02	3.17E-09	1.80E+00	5.70E-09	1.78E-05
5	4.0E-01	6.810E-06	3.900E-03	8.15E-08	5.00E-02	5.53E-09	1.50E+00	8.30E-09	6.90E-06
Total Risk									7.25E-03

**APPENDIX C**  
**STATE CONCURRENCE LETTER**



2600 Bull Street  
Columbia, SC 29201-1708

September 30, 2002

5 9 0134  
U.S. EPA REGION 4  
OFFICE OF  
REGIONAL ADMINISTRATOR

2002 SEP 34 P 1:59

COMMISSIONER:  
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Regional Administrator  
U.S. EPA, Region IV  
Atlanta Federal Center  
61 Forsyth Street, SW  
Atlanta, Georgia 30303

Re : Arkwright Landfill Site  
Spartanburg, South Carolina  
Final Record of Decision

Dear Mr. Palmer :

The Department has reviewed and concurs with all parts of the Record of Decision (ROD) dated September 2002 for the Arkwright Landfill Site located in Spartanburg, South Carolina. In concurring with this ROD, the South Carolina Department of Health and Environmental Control (SCDHEC) does not waive any right or authority it may have under federal or state law. SCDHEC reserves any right or authority it may have to require corrective action in accordance with the South Carolina Pollution Control Act. These rights include, but are not limited to, the right to insure that all necessary permits are obtained, all clean-up goals and remedial criteria are met, and to take separate action in the event clean-up goals and remedial criteria are not met. Nothing in the concurrence shall preclude SCDHEC from exercising any additional administrative, legal, and equitable remedies available to the Department that require additional response actions in the event that: (1)(a) previously unknown or undetected conditions arise at the site or (b) SCDHEC receives information not previously available concerning the premises upon which SCDHEC relied in concurring with the selected alternative; and (2) the implementation of the remedial alternative selected in the ROD is no longer protective human health or the environment.

The Department has reviewed and issued an approval to USEPA on all documents used in evaluating the site except the Baseline Risk Assessment (BRA). As of the date of this letter, we have not received a BRA sufficient to approve based on an evaluation of Risk Assessment Guidance for Superfund (RAGS), EPA Region IV Supplemental Guidance to RAGS and the EPA Draft Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk

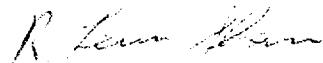
Assessments. However, because the Department believes an accurate and complete remedial evaluation can be made for the site without the approved BRA using ARARs and Presumptive Remedy Guidance, we are proceeding with the concurrence process.

The Department concurs with the four major components of the Selected Remedy as described in the ROD. We concur that Institutional Controls, including a restrictive covenant, will be employed at the site to prevent future exposure to soil contaminants and underlying landfill material. We concur with the use of the Presumptive Remedy component that consists of the construction of a flexible membrane liner (FML) cap over the existing landfill material. This concurrence is predicated on the fact that the FML cap will be constructed and monitored in accordance to ARARs for solid waste landfills.

The Department concurs with the remedy components for groundwater that include implementation of an enhanced biodegradation process and long-term monitoring. According to the ROD, a pilot scale study(s) will be conducted during the Remedial Design to determine delivery strategies, target treatment areas, and possible treatment solutions/reagents for the enhanced biodegradation process. The Department understands that the timing of the final groundwater remediation process may depend on the successful construction of the FML cap. Finally, this concurrence requires that a long-term groundwater monitoring network and sampling plan will be submitted for Department approval during the Remedial Design.

If you should have any questions regarding the Department's concurrence with the ROD, please contact Scott Wilson at (803) 896-4077.

Sincerely,



R. Lewis Shaw  
Deputy Commissioner  
Environmental Quality Control

cc : Hartsill Truesdale, BLWM  
Keith Lindler, BLWM  
Richard Haynes, BLWM  
Scott Wilson, BLWM  
Kent Coleman, BLWM  
Cindy Carter, APPIII  
54475; file

**APPENDIX D**  
**SELECTED REMEDY COST SUMMARY**

**APPENDIX D**  
**Selected Remedy Cost Summary**

<b>Soil Component (Presumptive Remedy) - Capping</b>								
<b>Item</b>	<b>Item Description</b>	<b>Unit</b>	<b>Unit Cost \$</b>	<b>Basis or Qualification</b>	<b>Qty</b>	<b>Basis of Quantity</b>	<b>Item Cost</b>	<b>Total Cost</b>
<b>Direct Capital Costs</b>								
1.00	Mobilization	LS	32,000	1% of direct capital costs; H&S, office, phone, water, Porta-Johns, etc.	1	Contractor experience	32,000	32,000
	Total Mobilization							32,000
2.00	Site Work							
2.10	Cut access roads	LF	5.00	Grade, minimal stone, extent of fill area	4500	Around perimeter	22,500	
2.20	Clear site, grub & chip	AC	2800	Means Cost Est Guide	28	Entire area	78,400	
	Total Site Work							101,000
3.00	Excavate and Haul Trash							
3.10	Offsite mound removal	CY	10.00	Contractor experience	12,000	CADD volume	120,000	
3.20	Move waste to stabilize slopes	CY	10.00	Contractor experience	47,000	CADD volume	470,000	
3.30	Remove waste in corridor	CY	10.00	Contractor experience	9600	CADD volume	96,000	
	Total Excavate and Haul Trash							686,000

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**APPENDIX D**  
**Selected Remedy Cost Summary (cont'd)**

**Soil Component (Presumptive Remedy) - Capping (continued)**

Item	Item Description	Unit	Unit Cost \$	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
4.00	Install Cap							
4.10	Install synthetic liner	SF	0.45	Means CE Guide	1.09 million	Calc; 2 separate capped areas	490,506	
4.17	Purchase of Cover Material	CY	3.20	Purchase price	121,113	25 AC, 24-inch soil plus 6-in. for topsoil	387,562	
4.19	Load, haul, dump, grade. compact	CY	9.30	\$8.00 to cut and haul	80,742	Soil cover only	750,899	
4.22	Manufacture topsoil	CY	3.00	Contractor experience	40,371	12 in. over the Site	121,113	
4.23	Load, haul, dump, grade. compact	CY	8.20	Contractor previous job	40,371	12 in. over the Site	331,041	
4.25	Grade and Hydro-seed	AC	3494	Means CE Guide	30	Site is 30 acres	104,820	
4.29	Construct diversion ditches	LF	12.32	Means CE Guide	1,569	Calc/Site drawings	19,330	
	Total Install Cap							2,205,000
5.00	Install Down Drains, Paved Ditches							
5.10	Fine grade, install geotextile	SY	2.82	Means CE Guide	1651	Calc, hand-work, partial rolls	4,655	

**APPENDIX D**  
**Selected Remedy Cost Summary (cont'd)**

**Soil Component (Presumptive Remedy) - Capping (continued)**

Item	Item Description	Unit	Unit Cost \$	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
Soil Component (Presumptive Remedy) - Capping (continued)								
5.12	Install Rip-Rap	LF	18.08	Means CE Guide	1486	Calc/Site drawings	26,858	
	Total Install Down Drains, Paved Ditches							32,000
6.00	Passive Gas Collection							
6.10	Trenching and Backfill	LF	9.00	Includes sand backfill (Means)	3561	Calc - perimeter@top of 3to1, plus top area	32,049	
6.12	Collection piping	LF	11.99	6-in. perforated HDPE	3561	(same as 6.10)	42,696	
6.14	Dispersion stacks	EA	190.10	10 ft high	18	Calc - every 200 ft	3,422	
	Total Passive Gas Collection							78,000
7.00	Soil & Erosion Control							
7.10	Silt fencing	LF	5.89	Means CE Guide	4000	Calc	23,560	
7.20	Construct mud pad	EA	450	Contractor experience	3	Assume replace 3x	1,350	
	Total Soil & Erosion Control							25,000
8.00	Public Road Repair							
	Public Road Repair	SY	5.50	Means CE Guide	6667	Calc - 3333 LF of road	36,667	

**APPENDIX D**  
**Selected Remedy Cost Summary (cont'd)**

**Soil Component (Presumptive Remedy) - Capping (continued)**

Item	Item Description	Unit	Unit Cost \$	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
	Total Public Road Repair							37,000
9.00	Site Fencing							
	Site Fencing		17	Means CE Guide	4261	CADD computed	72,437	
	Total Site Fencing							72,000
Subtotal Direct Capital Costs								3,268,000
Indirect Capital Costs								
11.00	Engineering Services							
11.10	Design	LS		5% of direct capital costs	1	(5% of 3,268,000)	163,400	
11.11	Work Plan, Project Manual	LS	15,000	Contractor experience	1		15,000	
11.12	Contract Management	LS	32,680	1% of direct capital costs	1		32,680	
11.13	Project Management	HR	80	Field Rate	100	Contractor estimate	8,000	
11.14	Construction Oversight	HR	65	Field rate, car, per diem	2080	52 wks x 40 hrs/wk	135,200	
	Total Engineering Services							354,000
12.00	Other Services							
12.10	Permitting and Legal Costs	LS	25,000	Contractor estimate/experience	1		25,000	
12.11	Final Report Writing	HR	85	Average Professional Rate	60	Contractor estimate	5,100	

**APPENDIX D**  
**Selected Remedy Cost Summary (cont'd)**

**Soil Component (Presumptive Remedy) - Capping (continued)**

Item	Item Description	Unit	Unit Cost \$	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
	Total Other Services							30,000
Subtotal Indirect Capital Costs								384,000
Subtotal Indirect Capital Costs								384,000
Subtotal Direct Capital Costs (from above)								3,268,000
Contingency (25% of direct capital costs)								913,000
<u>TOTAL CAPITAL COSTS - CAPPING</u>								<u>\$ 4,565,000</u>
Annual Operations and Maintenance (O&M) Costs								
20.00	Operations and Mainten.							
20.12	Gas Collection- Monitoring Maintenance and Operation	YR	2,000	Contractor estimate	1		2,000	
20.15	Cap maintenance	AC	1,000	Contractor estimate	27	Cap area + perimeter	27,000	
20.18	Administration and Reporting	YR	15,000	Contractor estimate	1		15,000	
20.19	Contingency	LS	11,000	25% of O&M cost	1		11,000	
	Total Annual O&M							55,000
TOTAL PRESENT WORTH VALUE, 30 years O&M Costs (55,000) at 7% discount rate								675,000
TOTAL PRESENT WORTH VALUE, PRESUMPTIVE REMEDY (CAPPING)								\$5,240,000

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**TABLE L-1**  
**Selected Remedy Cost Summary (cont'd)**

**Groundwater Component - Enhanced Biodegradation**

Item	Item Description	Unit	Unit Cost \$	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
Direct Capital Costs								
1.00	Install Monitoring Well							
1.10	Driller Mobilization	LS	500	Contractor experience	1		500	
1.11	Installation of Well	FT	65	Contractor experience	60	60 ft well, 6-in. casing, 2-in. PVC well	3,900	
	Total Install Monitoring Well							4,400
2.00	Application of HRC							
2.10	Mobilize/demobilize	LS	1,000	Contractor experience	1	108 points @ 20 ft; 177 points @ 10 ft	1,000	
2.11	Purchase of HRC	LB	6.00	Bid price received	8,000	4,000 ft of injection, 2lbs/ft	48,000	
2.12	Geoprobe for Injection	DAY	1,500	Contractor experience	12	Avg of 25/day installed	18,000	
2.13	Preparation, Contracting, Summary Report	LS	15,000	Contractor experience	1		15,000	
2.14	Construction Documentation	DAY	1,000	10 hrs/day @ \$85.00/hr plus per diem	12	Initial application	12,000	
2.15	Permitting, Regulatory Assistance	LS	5,000	Contractor experience	1		5,000	

**APPENDIX D**  
**Selected Remedy Cost Summary (cont'd)**

**Groundwater Component - Enhanced Biodegradation (cont'd)**

Item	Item Description	Unit	Unit Cost \$	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
	Total Application of HRC (Initial Event)							98,000
3.00	Treatability Study							
3.10	Prepare Work Plan	LS	5,000	Similar site experience-Contractor	1		5,000	
3.20	Install Observation Points	LS	10,000	Similar site experience-Contractor	1		10,000	
3.30	Inject Amendment	LS	25,000	Similar site experience-Contractor	1		25,000	
3.40	Sampling and Analysis	LS	15,000	Similar site experience-Contractor	1		15,000	
3.50	Treatability Study Report	LS	10,000	Similar site experience-Contractor	1		10,000	
	Total Treatability Study							65,000
Subtotal Direct Capital Costs								167,000
Indirect Capital Costs								
4.00	Engineering Services							
6.10	Preparation and Oversight	HR	90	Field Rate-Contractor experience	40	Oversee well installation	3,600	
6.20	Prepare CERCLA Design	LS	75,000	Contractor experience-similar sites	1		75,000	
6.30	Legal Services	LS	5,000	Estimate for deed restriction (if necessary)	1		5,000	
	Total Engineering Services							83,600

**APPENDIX D**  
**Selected Remedy Cost Summary (cont'd)**

**Groundwater Component - Enhanced Biodegradation (cont'd)**

Item	Item Description	Unit	Unit Cost \$	Basis or Qualification	Qty	Basis of Quantity	Item Cost	Total Cost
Subtotal Indirect Capital Costs								83,600
Subtotal Indirect Capital Costs								83,600
Subtotal Direct Capital Costs (from above)								167,000
Contingency (25% of direct capital costs)								<u>37,590</u>
<u>TOTAL CAPITAL COSTS - GROUNDWATER</u>								\$ 288,190
Annual Operations and Maintenance (O&M) Costs								
7.00	Operations and Maint.							
7.10	Maintain Monitor Wells	YR	3,000	Contractor experience-similar sites	1		3,000	
7.20	Groundwater Monitoring - Analytical Costs	EA	120	VOC analysis per sample	46	Semiannual, 16 wells + 1 blk + 6 surf water loc's, 3 days per event	5,520	
7.30	Groundwater Monitoring, Labor and Expenses	DAY	1,700	Two persons 10 hrs	3	Three days per event	5,100	
7.40	Administration and Reporting	YR	20,000	Contractor estimate	1		20,000	
7.50	Contingency	LS	8,405	15% of O&M Cost	1		8,405	
Total Annual Operations and Maintenance								42,025

**APPENDIX D**  
**Selected Remedy Cost Summary (cont'd)**

**Groundwater Component - Enhanced Biodegradation (cont'd)**

	Total Annual Operations and Maintenance	42,025
TOTAL PRESENT WORTH VALUE, 30 years O&M Costs (42,025) at 7% discount rate		516,000
TOTAL CAPITAL COSTS - GROUNDWATER		\$ 288,190
TOTAL PRESENT WORTH VALUE, ENHANCED BIODEGRADATION		\$ 804,000
PRESENT WORTH, PRESUMPTIVE REMEDY (CAPPING)		\$5,240,000
PRESENT WORTH, ENHANCED BIODEGRADATION		804,000
SELECTED REMEDY TOTAL		\$ 6,044,000